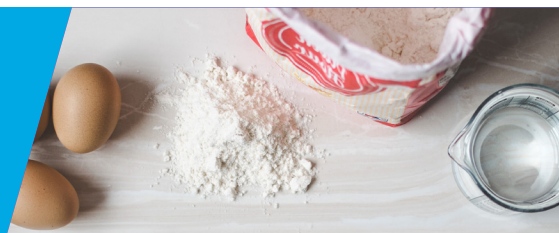


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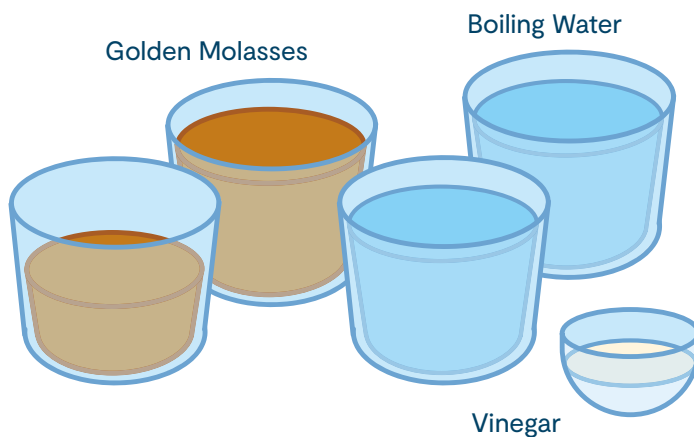
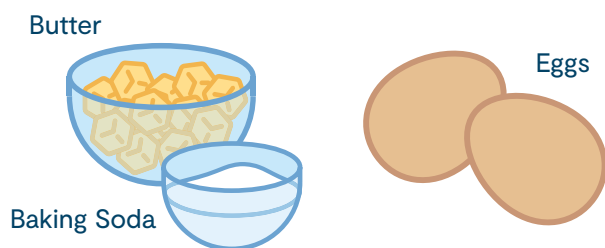
SHOOFLY PIE: RECIPE REACTIONS



Chemical reactions are happening all around us! Make a Pennsylvania-Dutch dessert called Shoofly Pie, then learn the complex chemistry that goes on inside it!

MATERIALS

- 2 cups flour
- 1 cup brown sugar (golden brown preferable over dark brown)
- 4 Tbsp butter (cold, and chopped into small cubes [or made crumbly by food processor])
- $\frac{3}{4}$ tsp salt
- 2 eggs (room temperature)
- 1.5 cups golden molasses
- 2 tsp baking soda (as fresh as possible)
- 2 cups boiling water
- 1 Tbsp vinegar
- Pie crust (use favorite ready-made pie crust, or recipe)
- Two mixing bowls
- 9-inch diameter pie pan (deep dish preferable)
- Rolling pin
- Whisk (or fork)
- Measuring spoons and cups
- Pastry blender (or forks)
- Oven
- **Optional:** $\frac{1}{2}$ tsp Nutmeg, 1tsp Cinnamon, and $\frac{1}{4}$ tsp Ground Cloves



Experiment continued on next page...



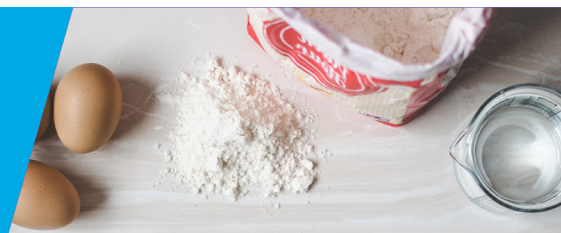
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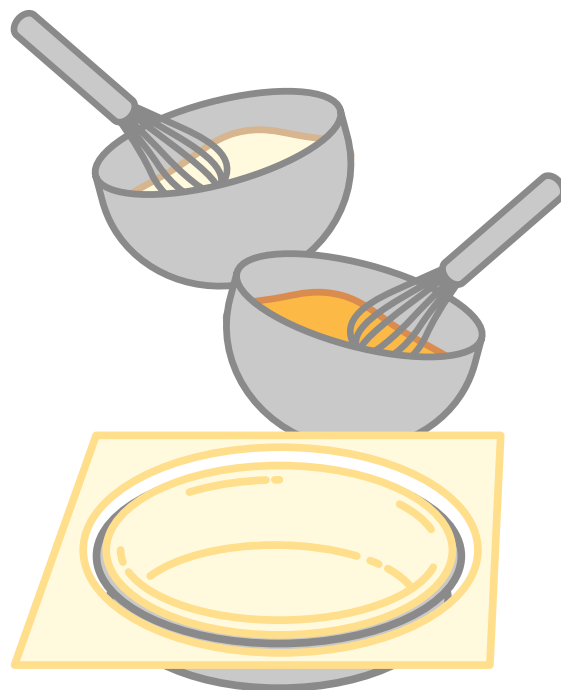
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SHOOFLY PIE: RECIPE REACTIONS



PROCEDURE

- Preheat your oven to 350 degrees
- Mix the flour, brown sugar, butter, salt, and baking soda into a large bowl. (option to add nutmeg, cinnamon and/or ground cloves here as well here). Mix it together with the pastry blender, or fork, until it all looks the same.
- In a separate bowl, mix the eggs, molasses, and vinegar together. Whisk them until the mixture all looks the same.
- Roll out the pie dough with the rolling pin until it's all flat and smooth, then put it into the pie dish. Make sure it covers the sides and bottom, and there are no cracks or gaps.
- Boil the water. An easy way to do this is to put it into the microwave for a few minutes. Make sure you're using a microwave-safe bowl for it!
- Have your adult SLOWLY pour the boiling water into the egg/molasses/vinegar mixture, while you stir it.
- Let the mixture cool down for a couple of minutes.
- Pour half of the molasses mixture into the pie crust. Then, layer on half of the flour mixture. Then layer the other half of the molasses mixture, and finally the other half of the flour mixture. You'll want to do it all somewhat quickly, and make sure the filling isn't taller than the pie crust!
- Finally, put the pie in the oven for 50 minutes. You can tell it's done when you stick a butter knife into the middle, and it comes out clean when you pull it out.
- Once it's done baking, take it out and let it cool down. Then it's ready to eat!



- ◀ Flour Mixture
- ◀ Molasses Mixture
- ◀ Flour Mixture
- ◀ Molasses Mixture

Experiment continued on next page...



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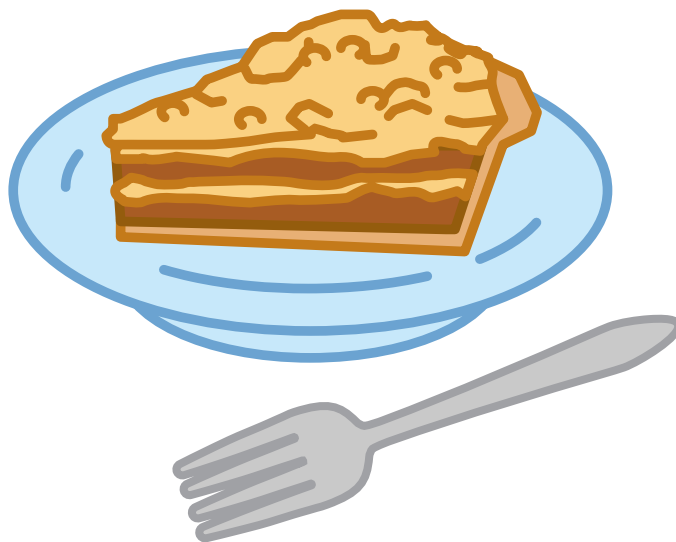
SHOOFLY PIE: RECIPE REACTIONS



DID YOU KNOW

There's a few different chemical reactions going on all at once here. Most importantly, the mixture of flour, sugar, butter, eggs, and water creates cake batter! Specifically, cake batter is made from flour, a sweetener, eggs, some kind of fat, water, and what's called a leavening agent, such as baking soda, baking powder or yeast. When you heat up cake batter, the leavening agent helps make carbon dioxide gas, which is what makes cakes soft and spongy. This is why cakes and breads rise when you bake them! At the same time, the flour and water link together to form gluten, a tough material that provides the cake with structure and firmness. The sugar, butter, and eggs provide flavor, making the cake taste as sweet and rich as it does.

However, you may notice that this recipe doesn't actually have a leavening agent in all parts of the filling. This is where the vinegar and baking soda come in. When baking soda and vinegar react with each other, it releases carbon dioxide gas, making the mixture bubble and foam. This gas is what acts as the leavening agent, creating bubbles within the batter that keep it from turning into a solid block. So, as the pie cooks, the dry mixture combines more and more with the molasses mixture as the carbon dioxide bubbles form, creating a mixed cake batter. The molasses keeps this reaction from happening too suddenly, as well as providing flavor!



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SHOOFLY PIE: RECIPE REACTIONS



K–2 GRADE EXPLORATION

Here are some questions you can explore together:

- Why should you add the boiling water slowly? What would happen if you added it quickly?
- Why is this called a pie instead of a cake? If you had to make this recipe into a cake, how would you go about it?
- Let's take a closer look at the chemical reaction going on inside the pie. Have an adult help you mix together 1 tsp baking soda and 1 tsp vinegar in a small bowl. What do you notice? Try it again with 2 tsp baking soda to 1 tsp vinegar, and again with 1 tsp baking soda and 2 tsp vinegar. What did you notice in trial 2 and trial 3?



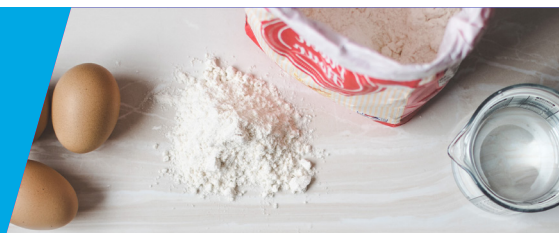
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SHOOFLY PIE: RECIPE REACTIONS



3–5 GRADE EXPLORATION

Explore the following questions and record your answers in your science notebook.

- Why is the temperature of the butter and eggs important? How would the butter change if it were warm? How would the eggs change if they were cold? How would those changes alter the recipe?
- Where does molasses come from? What chemicals is it made of? How is it made? Make a prediction, then look up the answer.
- Let's take a closer look at the chemical reaction going on inside the pie. Have an adult help you mix together 1 tsp baking soda and 1 tsp vinegar in a small bowl. What do you notice? Try it again with 2 tsp baking soda to 1 tsp vinegar, and again with 1 tsp baking soda and 2 tsp vinegar. What did you notice in trial 2 and trial 3?
- Baking powder is another example of a leavening agent. Would the chemical reaction change if you used baking powder instead of baking soda? Try the above experiment with baking powder instead of baking soda. What do you notice? Record your observations in your science notebook.



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SHOOFLY PIE: RECIPE REACTIONS



6–8 GRADE EXPLORATION

Explore the following questions and record your answers in your science notebook.

- What is the difference between brown sugar and white sugar? How would the pie be different if you used white sugar instead of brown sugar?
- Baking soda is also known as sodium bicarbonate, a basic substance with a pH around 8.5. It can make you sick if you eat too much of it. Vinegar, on the other hand, is an acid with a pH of around 2.5, and can also make you sick if you drink too much of it. So why are both items safe to eat when combined in this recipe? Try testing this idea by combining the two ingredients in a bowl, and testing their pH before and after mixing them. You can look up a simple recipe for an at home red cabbage pH indicator to test the pH levels. Did the pH change? Why do you think it did?
- In the Shoofly Pie, the baking soda and vinegar react to produce carbon dioxide gas. To get a closer look at this reaction and the resulting gas, try this follow up experiment:
 - Gather materials: balloon, baking soda, vinegar, container with a small opening, such as a plastic soda/water bottle.
 - Have balloon nearby and ready to place on top of bottle. It may help to stretch out the neck of the balloon a bit.
 - Add $\frac{1}{4}$ cup vinegar into plastic bottle. Then add $\frac{1}{2}$ Tablespoon baking soda.
 - As quickly as you can, stretch the opening of the balloon over the top of the bottle.
 - Observe what happens next. What do you notice about the reaction happening in the bottle? What do you notice happening to the balloon?
 - Repeat the experiment, but change one of the variables. Perhaps use a different amount of vinegar, a different amount of baking soda, a different size container, or try baking powder instead of baking soda. Remember, changing just one variable at a time will help you to draw conclusions about how that change affects the outcome of the experiment.
 - Design a way to measure the amount of carbon dioxide being produced. How could you measure how large the balloon inflates to record the amount of carbon dioxide?



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