



Mission: Do same ingredients plus different builds equal different results?

Age: 8+

Materials: \$8

Time: 30 min

(Set-up: 5 min Activity: 20 min Clean-up: 5 min)

What you need:

Materials:

- 2 tbsp. butter, room temperature
- 4 slices of bread
- 4 slices of your favorite cheese
- Optional: 2 additional slices of bread and cheese, sliced deli meat, pepperoni, pineapple rings (for a "Hawaiian" version), tomato slice, or whatever you enjoy on a sandwich

Equipment:

- Spoon
- Large frying pan
- Spatula
- Butter knife
- Mixing bowl
- Plate

What to do:

1. Assemble a "Lovely Layered" sandwich: Spread 1/2 tablespoon of butter on a slice of bread and put it on the plate, buttered side down. Layer two slices of cheese on top. Spread 1/2 tablespoon of butter on a second piece of bread and layer it on top of the cheese, buttered side up. Set aside.
2. Assemble a "Monster Mixed" sandwich: Take the remaining bread and cheese slices and tear or chop them into small pieces. Toss them together in the mixing bowl. Add the remaining 1 tablespoon of butter to the bowl and mix thoroughly with a spoon. With your hands, pack the mixture together and shape it into a rectangle approximately the same size as the layered sandwich.
3. With help from a grown-up, heat a large frying pan over medium heat. If your pan is big enough, put the layered sandwich on one side of the pan and the mixed sandwich on the other at the same time. (Otherwise cook one first, then the other, being sure to cook them for approximately the same time.) Flip halfway through cooking until both sides are golden brown. Does the cheese melt faster on one?
4. Transfer all sandwiches to the plate and let them cool. Make some observations first: Which one is thicker? Is it easier to tear one apart? Now taste them: How do they compare?

Optional: If using special ingredients, make an additional "fancy" sandwich by repeating step one but adding in layers of extra ingredients. Fry as you did for the other sandwiches.

Clean-up:

Wash your dishes and enjoy your sandwich!

What's Happening?

You may have noticed that the different sandwiches had different properties. The layered sandwich was probably thicker while the mixed sandwich may have flattened out. The cheese probably melted slower in the layered sandwich, but each bite of it had the same amount of bread and cheese, unlike the mixed sandwich. This is a model of how different methods of processing, like layering or mixing, using the same materials can lead to different behaviors. If you experimented with making a "fancy" sandwich, it probably had more flavors and textures, but it might not be heated through or might have been harder to flip.

So What?



In our grilled cheese experiment, one sandwich has neat layers that all stack evenly upon each other. The mixed sandwich has different amounts of ingredients in each bite, with no layers. Layered materials are interesting to scientists because each layer can have different properties and new properties can emerge where the surfaces of different layers come into contact.

One application of layered materials is in building solar cells, which turn light from the sun into electricity. Common solar cells you may have seen in your community are typically very simple, just a few layers. We can also add more layers to a solar cell to make them more efficient because each layer can use a different color of light from the sun. But also like a "fancy" sandwich, more layers means they are harder to make. Because multilayered solar cells are more complicated and expensive, they are only built for special uses such as powering satellites in space.

NGSS Alignment of Grilled Cheese Stackers Activity

The information below may not include every area that this activity can be linked to NGSS concepts

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- **Middle School**

- ◇ Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.
- ◇ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

PS1.B: Chemical Reactions

- **Grade 5**

- ◇ When two or more different substances are mixed, a new substance with different properties may be formed.

Performance Expectations

5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

Crosscutting Concepts:

Cause and Effect

- Grade 3-5
 - ◇ Cause and effect relationships are routinely identified, tested, and used to explain change.
- Middle School
 - ◇ Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Engineering and Science Practices

Developing and Using Models

- Grade 3-5
 - ◇ Develop and/or use models to describe and/or predict phenomena.
 - ◇ Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution
- Middle School
 - ◇ Use and/or develop a model of simple systems with uncertain and less predictable factors.
 - ◇ Develop and/or use a model to predict and/or describe phenomena.
 - ◇ Develop a model to describe unobservable mechanisms.

Engineering and Science Practices

Planning and Carrying Out Investigations

- Grade 3-5
 - ◇ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- Middle School
 - ◇ Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.