



Engineer a Gingerbread House!

Engineers design, build, and test structures for a purpose. Structures need to be strong and stable to do their job and strong enough to withstand the forces acting on them. Explore the engineering process by planning, building, testing, modifying, and re-testing! Engineer a gingerbread house that is stable and strong that can resist forces acting on it. Can your gingerbread house withstand a candy load? Is it strong enough to withstand strong winds? Let's investigate!

What you will need:

- + Gingerbread (store-bought or make your own! See recipe below)
- + Royal icing (commercially prepared or make your own! See recipe below)
- + Serrated knife to cut gingerbread (adult supervision is recommended)
- + Paper
- + Pencil
- + Piping bag with tips or simply use a zip bag with the corner snipped.
- + Scissors (adult supervision is recommended)
- + Decorations that are fun to eat, like pretzels, marshmallows, chocolate chips, sprinkles, etc.

Gingerbread Recipe

Ingredients:

- 6 cups flour
- 1 tsp baking soda
- ½ tsp baking powder
- 1 cup butter (room temp)
- 1 cup brown sugar
- 4 tsp ground ginger
- 4 tsp cinnamon
- 1 ½ tsp ground cloves
- 1 tsp black pepper
- 1 ½ tsp salt
- 2 large eggs
- 1 cup molasses



- + In a large bowl, sift together flour, baking soda and baking powder. Set flour mixture aside.
- + Beat butter and sugar. Mix in the spices, then salt and eggs. Add flour mixture in 3 lots and mix well. Use hands if necessary.
- + Divide into 2 or 3 sections, flatten and wrap in plastic and chill for an hour. While the dough is chilling, read the section, "Start Planning and Building."
- + Preheat oven to 350 degrees. Line baking sheets with parchment paper. Set aside.
- + On a lightly floured surface, roll out dough, cut into desired shapes, place on cookie sheets.
- + Bake for 10-12 minutes, then cool for 10 minutes before removing from sheet.

Start Planning and Building:

The first step of building a structure is planning! What will your gingerbread house look like? Will you be adding a chimney, windows, and a balcony? Will it be a one-level structure or two? Plan first. Then sketch your gingerbread house using pencil and paper. What will you build first, the roof, the walls? Do you need to cut out the windows before you start putting it all together?

How can you stabilize your structure so that it is stable and strong? Will you be adding triangles*, supporting beams? What parts of the house will carry the heaviest load?

*The triangle is the strongest shape! Triangles have 3 sides and are extremely stable. When pressure is applied to the side of a triangle, it absorbs the pressure and remains sturdy. Look at some examples of architecturally famous and strong structures that use triangles, like the Eiffel Tower, Great Pyramids of Giza, and the Louvre Pyramid.

When your plan is ready, return to your chilled dough, roll it, cut into desired shapes and bake. Once gingerbread has baked and cooled, begin putting your pieces together and use royal icing to glue it all together.

Stable and Strong!

Once you have all of the structural elements in place, ask yourself the following questions. Does your house stay upright? Is it keeping its shape? If not, how can you improve your structure? Will your house be able to support the weight of the candy? Are there any weak spots that need to be identified and modified?

Once you are satisfied with your structure, begin decorating your house. Remember, your house will need to be stable in order to withstand this extra weight.

Why do we use Royal Icing? Taste vs Strength!

Royal icing isn't as tasty as traditional cake icing such as buttercream or cream cheese but it is much stronger! Royal icing is the glue in this engineering project. It is what will keep all the pieces together. The special ingredient in royal icing is the addition of egg whites.

Royal Icing Recipe

Ingredients:

3 egg whites at room temp*, 3/4 teaspoon cream of tartar, and 1 lb. icing sugar.

Directions: Combine all ingredients in the bowl of a mixer. Mix on high for 7-10 minutes. Beat until very stiff. Store at room temperature. Cover with plastic.

*Use egg whites from pasteurized eggs to prevent the risk for Salmonella infection (especially for pregnant women, children, elderly, and those with health concerns). Pasteurized eggs reduce food contamination dramatically. Alternatively, substitute meringue powder for egg whites.

Recipe adapted from Lee Garden Cast Iron Gingerbread House Mould



Extension activity (optional): The North Pole Wind Test

Can your gingerbread house withstand forces like wind?

To test your gingerbread house, hold a hair dryer (cold setting only so icing does not melt) about 10 cm away from the house. Blast air for about 30 seconds on each side to see if the gingerbread house remains stable and strong. Alternatively, you can also use a fan.

The Science!

Egg white is about 90% water and 10% protein (proteins are long chains of amino acids). The proteins in egg whites change when they are beaten, heated, or whipped. In their natural form, the proteins in egg whites are globular proteins which means that the long protein molecule is twisted and folded and curled up. The curled proteins float around in the water.

Some amino acids like water (hydrophilic, or water-loving) and some do not (hydrophobic, or water-fearing). Beating the egg whites introduces air bubbles into the mixture and this helps uncurl and stretch out these proteins. As you mix, the water molecules and the protein molecules start bouncing around. The protein begins to uncurl so that the water-loving parts can be immersed in water and the water-fearing parts can stick to the air. The protein uncurls and forms new bonds that are much stronger.

Tip: Egg whites at room temperature can be beaten to a foam more easily than cold egg whites.

