

Rapunzel's Tower Challenge

Design Rapunzel's Tower



A sinister king has ordered Rapunzel, a princess with the longest hair in the world, to be locked in a tall tower. The king has commissioned you to design and build that tower. You have decided to include a window so that Rapunzel can secretly receive items that she may need.

Activity Challenge

Design and build Rapunzel's tower that stands 2-3 feet tall. The tower needs to be strong enough so that Rapunzel can lift the items she needs with her long hair. The tower also needs a window at the top so her hair can hang outside the tower.

Preparation

1. Review the **Materials Needed** list.
2. Select tower materials for durability and strength.
3. Define a workspace. This project will need about 3 feet of floor or table space.
4. Have trash and recycle bins ready to collect scraps.

To Do

1. To start, think about how to build a tower that is 2-3 feet high with only the materials on hand. Make a drawing of your plan for building the tower.
2. Using the drawing, build the tower. A few things to think about:
 - a. The tower does not have to be round.
 - b. The tower will need a strong base so that it can stand on its own and support objects being lifted from the top. Putting weight at the bottom and/or making a wide base can help.
 - c. Try building without tape or glue. Think about mechanical ways to attach pieces together such as using toothpicks to pin pieces together.

Materials Needed

Materials to make a tower such as:

- Cardboard, cereal boxes, containers
- Craft sticks, chopsticks, skewers, toothpicks, etc.
- Scissors
- Arts and crafts supplies: colored paper, markers, colored pencils
- Objects for weights such as paper clips, binder clips, etc.
- Tape or glue
- String

Grade Range

3-5

Topics/Skills

Engineering Design

Learning Standards

[3-5 Engineering Design](#)

Duration

45 - 90 minutes

Prep Time

30 - 45 minutes

3. Test the tower:
 - a. Tie or otherwise attach a string to the top of the tower, near the window. Let the string hang down until it almost touches the floor or table surface.
 - b. At the bottom of the string, tie on a small handful of paper clips or other object(s).
 - c. Hang the string from the tower, make sure the objects are not resting on the floor.
 - d. Keep adding weight to test the strength of the tower.
 - e. See how much weight the tower can hold before it falls over.
4. Make adjustments to the tower so it can support more weight if needed.

Observations

If the string were attached at the middle of the tower, would the tower be able to support more weight?

Extensions

- Attach a pulley to Rapunzel's Tower and see how much you can lift. See the Simple Pulley Learning Activity.
- How does friction hold things together?
- How does compression and tension hold things together?
- What is the Leaning Tower of Pisa and why does it lean?

The Science Behind the Activity

Remember trying to stack blocks as high as possible when building a tower? Those blocks always came tumbling down when the tower became unbalanced or was bumped. Stronger and taller towers were possible with blocks that connect firmly to one another. Towers made on a smooth floor were more stable, did not fall over, as often as towers built on a carpet or bed.

Early towers were made from sticks and logs that were joined together. Rocks or stone blocks could be found or made smooth sided enough to stack like blocks or be cemented together.

Simple block towers are more stable if the base is the widest and heaviest part of the tower. The best was to have each higher level of the tower be smaller than the layer below. Real towers must overcome the same challenges as toy towers and more!

Towers built on the ground could be blown over or, if heavy enough, sink into the ground. How could the towers be made more stable? One solution was to drive logs deep into the ground. Another way was to dig out the loose soil until firmer ground or solid rock (called "bedrock") was found. Many tall buildings have deep underground foundations of rock, concrete and/or steel to support the building that is aboveground.

To not collapse or fall over towers must also be constructed of strong enough materials, with strong enough connections (joints) and be balanced (stable). Additional strength and stability are needed if the tower is used support a weight tied to the top of the tower.