



**Title: Harnessing the Wind STEM Challenge**

**Estimated Time: 1-2 periods**

**Core Ideas (GSE Standard and elements):**

**S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment.** a. Ask questions to collect information and create records of sources and effects of pollution on the plants and animals. b. Explore, research, and communicate solutions, such as conservation of resources and recycling of materials, to protect plants and animals.

**S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.** a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives. b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.

**Literacy Connections: Books**

The Boy Who Harnessed the Wind, William Kamkwamba and Bryan Mealer  
Up in the Garden, Kate Messner

**Literacy Connections: Close Reads**

Windmills Help Power the World Close Read ES  
Windmills Help Power the World Close Read MS

**Science and Engineering Practices:**

**Planning and Carrying Out Investigations:**

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.

**Constructing Explanations and Designing Solutions:**

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

**Crosscutting Concepts:**

**Structure and Function:**

The way an object is structured/designed determines many of its properties and functions.

**Stability and Change:**

For designed systems, conditions that affect stability and factors that control rates of change are critical to consider and understand.

**STEM Challenge Overview:**

In this STEM Challenge, the student's task is to build a working model of a windmill that can be used to lift an object in a useful manner.

**Ask**

Have you read the book or seen the movie *The Boy Who Harnessed the Wind*? Based on a true story, a 13-year-old boy from a village in Malawi Africa removed from the school he loves when his family can no longer afford the fees. Determined to keep learning, he sneaks into the library to read and

	<p>research and, in the process, and learns how to build a windmill to help save his village from a famine.</p> <p>If you have time, read this book to your kids or check out the trailer for the movie at <a href="https://www.youtube.com/watch?v=ab-aZ92Vyuc">https://www.youtube.com/watch?v=ab-aZ92Vyuc</a>.</p>
<b>Imagine/Brainstorm</b>	<p>Students <b>brainstorm</b> ideas for how they could design and construct their own simple windmill. The windmill should be capable of lifting a few small objects from the floor to a desk or table. After brainstorming, they should consider the strengths and weaknesses of each idea.</p>
<b>Plan/Design</b>	<p>In order to learn more about topic, have them read the <i>Windmills Help Power the World</i> article and discuss how windmills are used to pump water, grind grain, and generate electricity into the air. It is a good idea to briefly discuss how modern windmills (wind turbines) are used to generate electricity.</p> <p>After learning about windmills, students <b>plan</b> and <b>design</b> a simple model windmill that can lift some simple objects a measureable distance. Depending on the level of your students and the time you have for this challenge, you can make this open-ended or more of a guided inquiry for your students. If you take a more open-ended approach, provide a greater variety of materials that can be used to construct the windmill and encourage more out of the box designs.</p>
<b>Create/Test</b>	<p>Students follow their plan, and <b>create</b> their model windmill. Once it is created, students <b>test</b> their windmill in a measureable way to evaluate the effectiveness of their solution. In this case, they test to see if their windmill can successfully lift some small objects up to the top of some destination. Their results should be recorded, organized, and analyzed.</p>
<b>Improve</b>	<p>After discussing and evaluating their results, students improve their solution and re-test if possible.</p>

### Teacher Notes:

With the new Georgia Standards of Excellence for Science, there is an increased emphasis on the design and development of solutions to practical problems. This STEM Challenge provides students with a chance to design and develop a functional windmill while considering how a similar device might provide green energy for our future energy needs. The challenge is made even more relevant and engaging given the incredible story and useful solution that was recently developed by a teenage African boy named William Kamkwamba. Chronicled first in a book and now in a movie, *The Boy Who Harnessed the Wind* offers some teachable moments that are difficult to come by.

This challenge also provides a good opportunity to teach and/or review about the fundamental nature and cause of wind. For elementary students, we should emphasize that **wind** is moving air and that we can use the energy in the wind to do useful things. We can also use tools called **windmills** that use the energy in the wind to do helpful things. Windmills have used for centuries to grind grain into flour for baking and pump water from one place to another.

Today, giant modern windmills, often called wind turbines, are used to generate electricity. Middle school students should understand that **wind turbines** convert the kinetic energy of the wind into

electrical energy that can be used for a variety of things. (You can also consider the forces that are involved in this process and how they act in this system). In windy areas, large wind turbines can be grouped together to form a wind farm. **Wind farms** are becoming an increasingly important source of power for many areas. The best thing about wind turbines is that the electricity is produced naturally without the burning of fossil fuels. As a result, wind power is considered a **green energy** source because it generates power without harming the environment. If time permits, have your students consider new ways that windmills could produce green energy to do some cool things that now require fossil fuels.

In the STEM Challenge itself the students' task is to build a windmill that can lift some small objects. A couple of templates for a basic windmill are provided that work well as a start but, as you and your kids gain confidence, you can let this part be much more open-ended. If you want the windmills to stay true to history, you could have them lift a small amount of water in the way that farmers often do to pull water up from deep underground wells. If you want to use it as part of a theme, you could incorporate some ideas such as:

1. Hoisting your Halloween candy to a suitable hideout
2. Pulling your pennies up to your piggybank where they will be safe from your sister
3. Moving your marbles off the floor where your mom won't stop on them.



**The windmill should include a:**

1. Strong base
2. Blades to catch the wind
3. A shaft that spins as it pulls up your object from below.
4. A bucket to hold and balance the objects that you lift.

**Suggested materials for students to use:**

Cardstock paper for blades (copy template onto the cardstock). Large paper or plastic cup (16-20 oz), small paper or plastic cup (Dixie size), 3-4 feet string, 1 wide straw (McDonalds or Chic-Fil-A are good), 1 skinny straw or a pencil, scissors, masking tape, objects for lifting (pennies, Skittles, marbles, etc.), 1-2 rubber bands.

## Vocabulary Cards:

### wind

naturally moving air



### windmill

a structure that uses energy in the wind to do helpful things



### wind turbine

converts kinetic energy in the wind into electrical energy



### wind farm

a group of wind turbines used to produce electricity



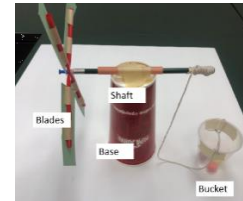
### green energy

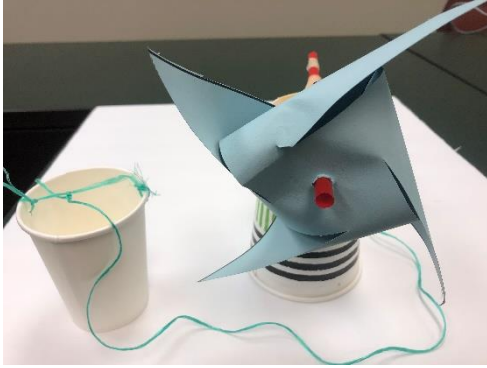
energy that generates power without harming the earth



### engineer

to design, build, and improve things



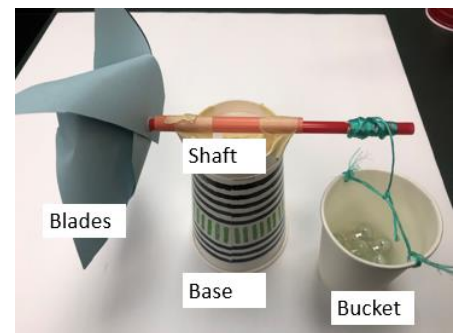


## Harnessing the Wind STEM Challenge:

Can you design, build, and test a model windmill that can be used to lift an object in a useful manner?

### Designing and constructing your windmill:

1. After learning about catapults, **plan** and **design** a simple model windmill that can lift an object to a specified location.
2. Using the materials provided and your plan, **construct** your model windmill. Your catapult should include a base, blades to catch the wind, a shaft to help the blades turn and a bucket to lift your objects.
3. As time permits, decorate your windmill to make it look as cool as possible.
4. Once the windmill is constructed, carefully **test** it trying it out with your marshmallow. Make sure to make measure how it performed.

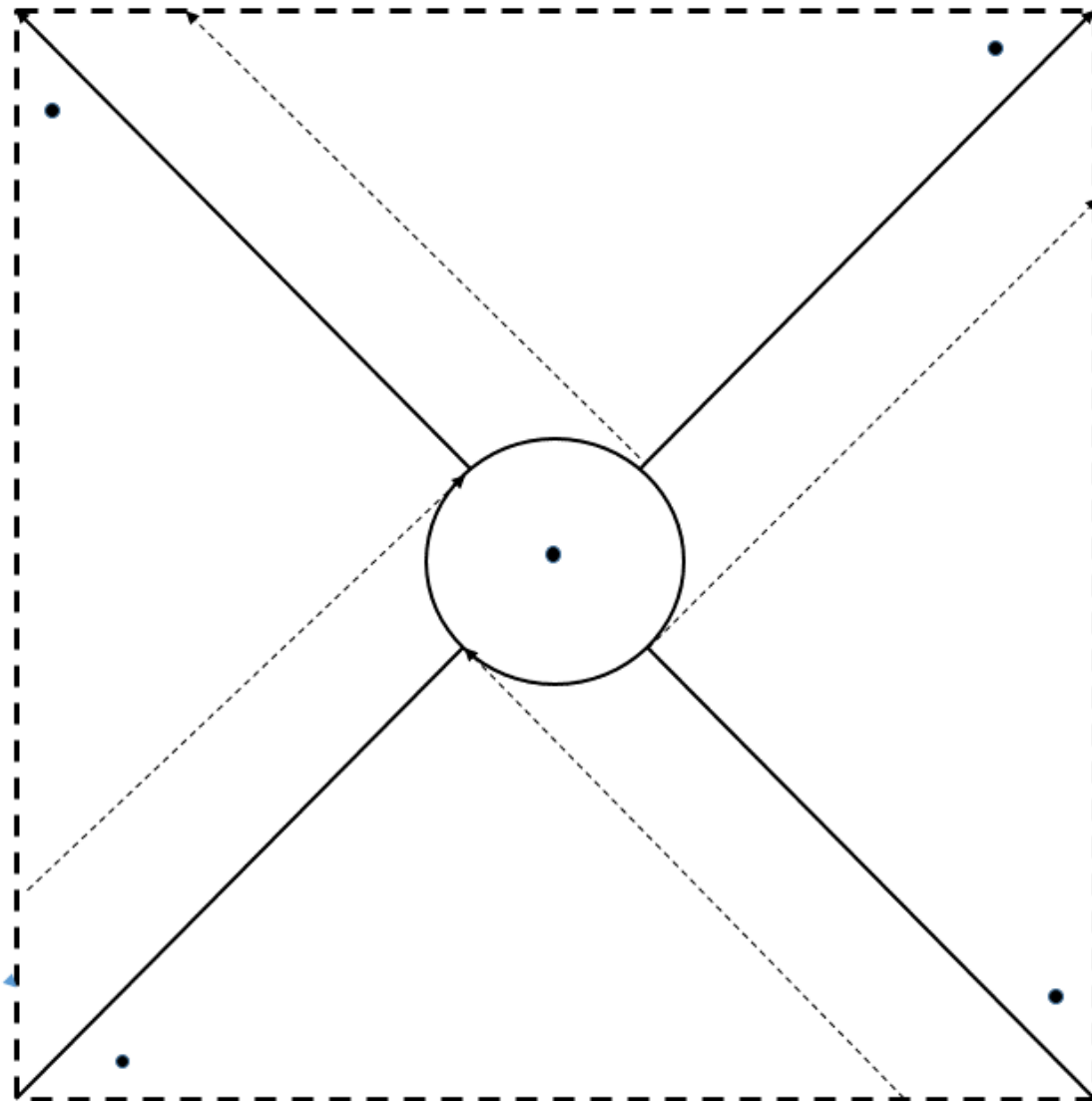


### Evaluating and Improving:

1. As a group, how did you measure the effectiveness of your windmill? Record your measurements below.
2. As a group, **evaluate** the effectiveness of your design and discuss how you would change your design moving forward to **improve** the performance of your windmill. If time permits, make these improvements and re-test.

# Windmill Template 1 GYSTC

1. Poke holes through the black dots on the template about the size of your small straw.
2. Cut along dotted lines of the template.
3. Push your small straw through the center hole.
4. Bend (don't fold) each of the corners toward the middle and attach them to the straw.
5. Secure the back and front of the windmill with tape and/or small rubber bands.
6. Cut your large straw about 1 inch longer than the bottom of the large cup. Flip it over and tape it on.
7. Slide the windmill through your large straw. The small straw should extend about 2 inches past your large straw.
8. Take your small cup and tape a small string to each side of it to create a bucket handle.
9. Measure out a piece of string so that it can go from the table to the floor. Tape it to the end of your small straw.
10. Blow on your windmill and see if you can get it to lift your cup.
11. Use the fan or blowdryer to see how many items you can lift at one time.
12. Great job. You have created a working windmill.



## Windmill Template 2 GYSTC

1. Poke holes through the black dots on the template about the size of your small straw.
2. Cut along dotted lines of the template.
3. Push your small straw through the center hole.
4. Bend (don't fold) each of the corners toward the middle and attach them to the straw.
5. Secure the back and front of the windmill with tape and/or small rubber bands.
6. Cut your large straw about 1 inch longer than the bottom of the large cup. Flip it over and tape it on.
7. Slide the windmill through your large straw. The small straw should extend about 2 inches past your large straw.
8. Take your small cup and tape a small string to each side of it to create a bucket handle.
9. Measure out a piece of string so that it can go from the table to the floor. Tape it to the end of your small straw.
10. Blow on your windmill and see if you can get it to lift your cup.
11. Use the fan or blowdryer to see how many items you can lift at one time.
12. Great job. You have created a working windmill.

