



2020 Minor Challenge Set #1

STEM Field: Mechanical Engineering

Level: Junior

Challenge Name: Windmills and Energy

Materials required:

- Three types of paper (Recommended: Construction paper, Cardstock, Printer paper)
- Plastic straws
- String
- Paperclip
- Tape
- Scissors
- Glue
- Wooden skewers
- Hole punch (optional)

Introduction:

Windmills use the power of wind energy and turn it into rotational energy. This rotational energy can be used to pump water or even generate electricity.

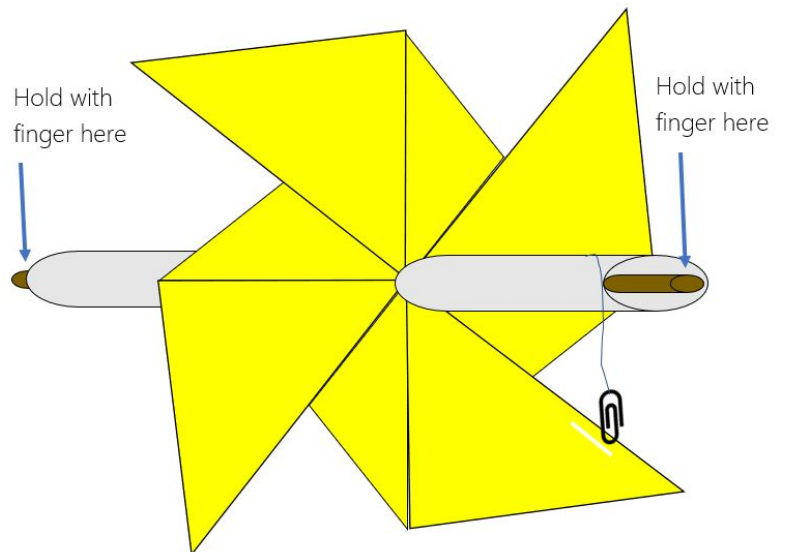
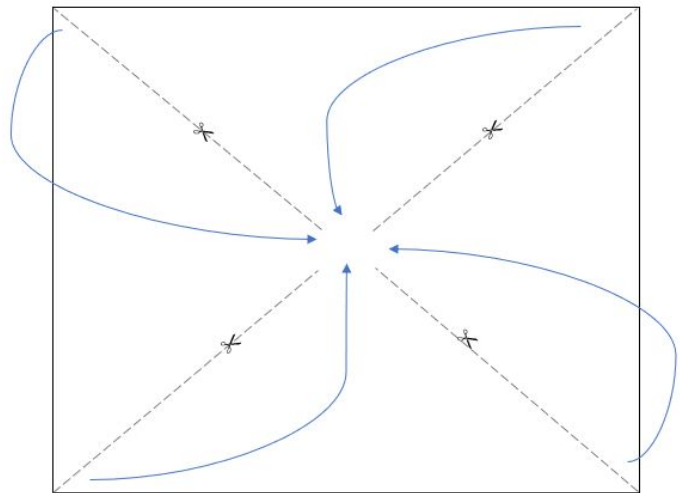
This is all due to the Law of Conservation of Energy, which says energy cannot be created or destroyed, only transformed. Here we are transforming natural wind energy into other useful forms of energy such as 'doing work'.

Work is very similar to the idea of a force such as pushing a box. When a force pushes an object in the direction of the force, then work has been done on the object.

In this experiment we will be using the Law of Conservation of Energy to do work on an object. Moving objects are examples of mechanical work!

Instructions:

- 1) Cut out a square of each type of paper.
- 2) Use a hole punch to make a hole in the centre of the square large enough for the straw to fit through.
- 3) From each corner of the square, cut towards the centre but stop about 1cm from the centre hole.
- 4) On each side of the square should be dangling triangle shapes. Take the left corner of each of these triangles and bend them towards the centre hole. Glue this left corner to the centre hole. This will create the 'sails' for your windmill.
- 5) Put a straw through the centre of each windmill.
- 6) Put a wooden skewer through the straw so it can rotate freely. Towards the end of the straw, tape one end of a piece of string to



the straw, each string should be at least 50cm. Tie or tape the other end of the string to a paperclip and let the paperclip hover in the air.

- 7) Hold each end of the wooden skewer with your fingers (one hand for each end) and blow on the sails of your windmill model. Watch the paperclip rise up as the sails spin.
- 8) Repeat for each type of paper. Which windmill works the best and why?

Extension: Other forms of Energy

Do some research on other forms of energy. In this challenge we looked at wind energy, rotational energy and mechanical energy. Since this is a Mechanical Engineering challenge, look for how different kinds of energy is turned into mechanical energy (moving things!). To get you started, one conversion is from electrical energy into mechanical energy. How can this be done?

Reflection Questions:

- What were the problems associated with the challenge? Are there any improvements you could suggest?
- What are the key concepts of science and engineering that relate to this challenge?

- From what you've said about which type of paper made the best windmill, what makes it better than the others as a windmill?
- Instead of doing mechanical work on pulling a paperclip up what else do you think we can use the rotational energy to do?
- The wind energy from your breath comes from another form of energy. What type of energy would this be?

Submission Guidelines:

- Submit a photo of the experiment setup. Include a short summary that addresses some of the Reflection Questions.
- In 2020 we have changed our submission guidelines compared to 2019. To submit fill out the form here:
<https://forms.gle/ChrCXLud97E4x3AT9>

Learn More! Resources:

- Physics Central - Blowing in the wind
<http://www.physicscentral.com/explore/action/wind.cfm>
- Energy.gov - How a Windmill works
<https://www.energy.gov/articles/how-wind-turbine-works>

Sources:

Education.com. (2019). Windmill Model Science Project | Science project | Education.com. [online] Available at:
https://www.education.com/science-fair/article/engineering_windmill/
[Accessed 18 Feb. 2019].