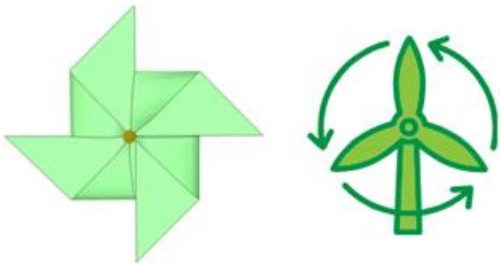
WIND AT WORK

Get wound up with wind power!



Curriculum topics:

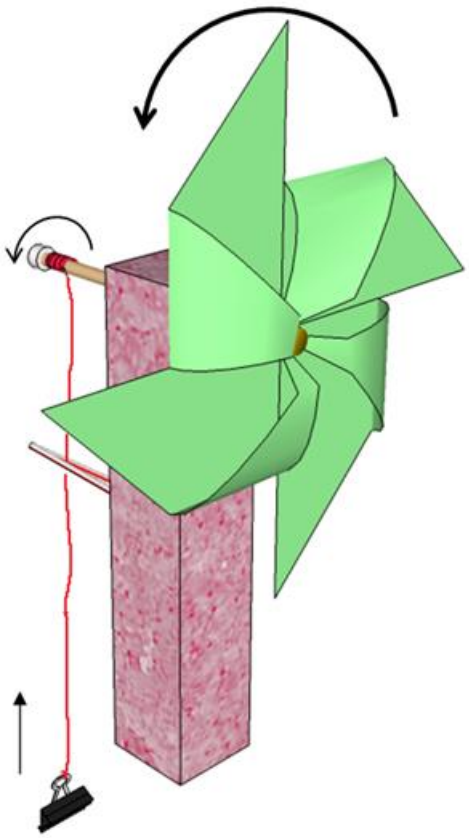
- Energy Conversion
- Wind
- Alternative Energy
- Investigations

Subject:

Physical Science, Earth/Space Science

Grade range: 3 – 12

Use this enhanced pinwheel to measure the mechanical energy that can be obtained from moving air. Make the pinwheel spin by holding the device while walking or by using the "wind" from a fan. Take data – including measuring how much time is required for the device to lift a set weight a fixed distance.



Who we are:

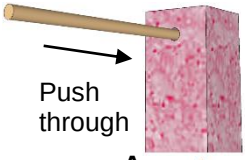
Resource Area for Teaching (RAFT) helps educators transform the learning experience by inspiring joy through hands-on learning.

For more ideas visit
https://raft.net/resources-2/

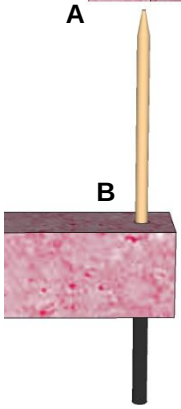
Materials required per windmill

- Foam block or equivalent, ~2“ x 9” (x1)
- Wood dowel w/ tapered end (x1)
- Straw section, ~3” long (x1)
- Pinwheel, cut from cardstock (x1)
- Paper fastener, ¾“ long (x1)
- String, 2 ft (x1)
- Stir straw, 7” long (x1)
- Small binder clip
- Weights (e.g, paperclips)
- Silicone tubing sections:
  - ¾“ long (x1)
  - ¼“ long (x2)
- Optional: Timer, powered fan (not included)

Set-Up



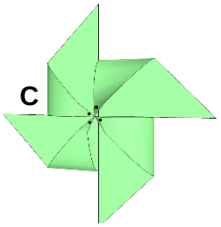
1 Carefully push the tapered end of the wood dowel all the way through the long side of the foam block near the middle and at a point ¾” from the end (**A**). Keep the dowel as parallel to the foam as possible and protruding from the foam.



2 Hold the straw section upright on a table and insert the flat end of the stick into the straw. Push down on the top of the foam block to force the straw through foam until the foam touches the table (**B**). Remove the stick from the straw.

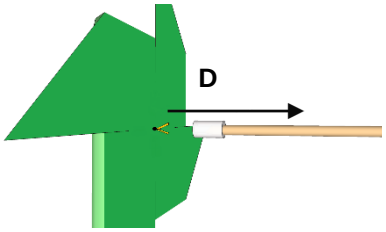
3 Form the pinwheel cut-out and insert the prongs of the ¾” paper fastener through the overlapped holes in the corners and then through the center (**C**). Spread the fastener prongs apart slightly to hold the corners in place.

4 Insert the tapered end of the wooden dowel into a ¾” long section of tubing (shown below) so the tapered end reaches the end of the tubing but does not stick out.



5 Attach the pinwheel by inserting the fastener prongs into the tubing so that the prongs enter on either side of the tapered end of the dowel (**D**). Carefully push on the head of the fastener to evenly insert the prongs in as far as possible.

6 Gently insert and press the other end of the dowel into the exposed end of the straw in the foam block. Slip a ¼“ tubing section over the other end of the dowel it is near the straw. Check that the dowel can spin freely.



7 Hold a string along the stick so that it extends beyond the end of the stick. Insert another ¼“ tubing section over the string and then the dowel. Stop when the tubing is fully inserted onto the dowel, securing the string in place.

8 Use a pencil to poke 2 holes halfway down the foam block on the same side as the string. Fold a stir straw in half, forming a V-shape. Insert the straw ends into the poked holes, aligning the point of the “V“ with the wooden dowel. Put the string through the “V” and tie it onto a binder clip handle.

Content Standards:

NGSS

Structure and Properties of Matter:
5-PS1-1

Definitions and Transfer of Energy:
HS-PS3-3

Forces and Motion:
3-PS2-1
3-PS2-2

Energy, Resources, and Environment:
4-ESS3-1

Human Impacts:
MS-ESS3-3
HS-LS2-7

Testing Variables (Engineering):
3-5-ETS1-3:

Decomposing complex real-world problems (Engineering):
HS-ETS1-2

To do and notice

1 Unwind the string completely and so the string falls straight from the stick to the folded straw. Tie a knot in the string 20" below the folded straw.

2 Cause the pinwheel to turn with natural or simulated wind. Measure how long it takes for the knot to reach the folded straw. Unwind the string and repeat the measurement.

3 Change a variable: Add one or more paperclips to the binder clip, change the fan speed (or walk faster), or move the pinwheel to a different location in front of the fan. Repeat, record time, and compare. Take additional measurements and form conclusions using the data.

The content behind the activity

An object in motion has **Kinetic Energy**. A heavy object traveling at a high speed has a lot of kinetic energy. But even things that are very light can still possess some amount of kinetic energy if they are moving. On a windy day, for example, the tiny molecules of gas in the moving air contain enough kinetic energy to blow your hat off! Like the hat, the blades of a **wind turbine** get pushed by the air pressing on the blades' angled surfaces. The angled surfaces cause the blades to rotate, creating rotational kinetic energy, at the same time the air passing over the blades is slowed slightly, reducing the wind's kinetic energy.

Wind energy can be collected by wind turbines and converted to more convenient forms, such as electrical energy to run motors or mechanical energy to turn a water pump. **Wind Farms** are large collections of wind turbines. They are often located on hilltops where strong, steady winds are common.

In this activity, "artificial wind" is created by moving a wind turbine through calm air inside a room. The relative motion creates kinetic energy, just as if a wind were blowing. Some of the wind energy is transferred to the turbine blades, causing them to spin. This energy is used to do **work**: lift a small weight attached to a string. The more wind, the more weight the turbine lifts!

Learn more

- Investigate different pinwheel sizes or shapes.
- Design a tail and pivot so the pinwheel always faces the wind.
- Convert the distance and time measurements into rotations per minute.
- Weigh the binder clip and paperclips to calculate the work done in lifting the weights a set distance.

Visit https://raft.net to view the following related activities!

Catching the Wind
Retractor Car
Rollback Can
Whimsical Wind Vane

Resources

- YouTube (3:16), Energy 101: Wind Power - https://bit.ly/3efdm6G
- How wind turbines work - https://bit.ly/2y3tUOA