

Wind Power with a Simple Pinwheel Machine

Key Physics Concepts in the Pinwheel Machine...

- **Potential Energy**
- **Kinetic Energy**
- **Mechanical Energy**
- **Newton's Laws of Energy Conservation**

Background

Just as a windmill was used to grind grain and lift water from the earth, we can replicate this simple machine with the use of a pinwheel. The wind energy (kinetic energy) caused by the uneven heating of the earth's surface, by the sun's energy, moves the air as it rises then cools and falls. This moving air spins the pinwheel. The spinning of the pinwheel transfers the kinetic energy to the pencil (shaft) attached to the pinwheel. The turning shaft, rubber band, and spools, represent potential and mechanical energy in the mechanical system. Each turn of the pencil continues to transfer the energy from the shaft to the thread spool. It then moves the rubber band, which moves the spool connected to the shaft of the water wheel, the spoons move the water from the pan. This is one of Newton's Laws of Energy Conservation which states "Energy cannot be destroyed only converted."

Activities to consider...

- Does the strength of the wind change the movement and transfer of energy through the system?
- Does the size of the pinwheel change the movement and transfer of energy through the system? Make a smaller pinwheel and test it.
- Can the energy move back through the system by pouring water to turn the water wheel? Will the turning of the water wheel cause the pinwheel to spin and create a wind?

Making a pinwheel wind machine (and water wheel)... Materials Needed

Machine Frame and general materials to use through the project...

- A soft wood stick (1"x 1/2"x 38") Cut to (2) 12" pieces and (2) 7" pieces
- (1) paper towel tube Cut (4) 1" pieces, (8) push pins, and (2) empty sewing thread spools
- (4) school pencils with erasers (thick enough to fit snugly into thread spool ends with no slipping), (4) metal washers and a large rubber band, (2) 1 1/2" brad nails and hammer
- (3) small tubs of playdoh or self-drying modeling clay and a hot glue gun

Pinwheel...

- A piece of cardstock and the pinwheel template (see resources)
- (1) push pin and scissors

Water Wheel...

- (6) plastic spoons and (9) popsicle sticks
- (1) empty sewing thread spool
- Heavy cutters to cut sticks and spoons to length

Machine Making Instructions...

The machine assembly takes time. Work slowly and follow each step carefully and above all, have patience with yourself.

Machine Frame:

Bring together the materials needed for the frame; (2) 12" and (2) 7" sections of soft wood sticks. Sandwich one end of each 12" pieces between the ends of the 7" pieces and using the brad nails secure the two 7" pieces to the top of the 12" sections. (See pictures) This will form an arched frame for the machine. Take the playdoh, mix together then separate into to balls (one side pressed flat so it will not roll) and press the ends of the two 12" sticks into the balls so the frame will stand on its own.

Take the paper towel roll, 1" sections and with a push pin, secure them to the 12" frame pieces. Two on each piece with one set about 2 1/2" from the top of the frame and the other about 7 1/2" from the top of the frame. (see pictures). Now cut the pencils into sections, measuring from the eraser end; into (1) 2 1/2" section, (1) 3" section, (1) 4 1/2" section, and (1) 5" section. Measurements here may vary with the size of the thread spools that you are using. To test the lengths make sure that one spool can be suspended between the paper towel sections on the top set with the erasers extending a little beyond the sections. You will use the 3" (for the pinwheel connection) and 4 1/2" pencils here. For the bottom paper towel sections, you will use the 2 1/2" section to fit below the top spool and the 5" section for the spool that forms the water wheel (See pictures).

Making the pinwheel, use the cardstock and copy the template. Follow the provided instructions in the resources and secure the pinwheel to the end of the 3" pencil eraser with a push pin and seal the connection with hot glue. The pencil should spin with the pinwheel.

Making the water wheel, cut (6) of the popsicle sticks in half and then cut the other sticks into (6) sections into the length of the spoon (about 2" for the one in the pictures). Using the hot glue gun, secure the half sticks to the ends of the spool, spacing them evenly and matching the sticks on the opposite end of the spool so the short sticks can be glued between the half stick sections (see pictures). Now cut the spoons so that the handle end can be glued onto the spool at each pair of half sticks and the bowl of the spoon will rest on the short sticks between the half sticks (see pictures). Let the wheel dry completely.

To assemble the bottom section of the machine, push the 5" section of pencil into the water wheel spool so that enough pencil comes out to push through the remaining spool. Now place the rubber band around the top spool and the remaining spool. Place the 2 1/2" pencil section into the other end of the remaining spool and through the paper towel section under the pinwheel. This will require stretching the rubber band tightly creating the tension that will turn the pencils as the pinwheel turns. One final step...to make sure that the pencils do not slip out of the paper towel loops, take the metal washers and the remaining push pins and push the washer on the pins and into each eraser end. Using a fan make the pinwheel spin and watch the water wheel turn in the transfer of energy; from the wind, to the pencils, to the top spool, to the rubber band to the bottom spool, the bottom pencil and the wheel. Next week we will watch it move water!

