RAFT IDEAS

Topics: Weather, Measuring Devices, and Velocity

Materials List

- ✓ CD or equal
- ✓ 6 Paperclips, smooth finish, #1
- ✓ Straw with a narrower diameter than a drinking straw
- ✓ Drinking straws, 2
- ✓ Straw with a slightly larger diameter than a drinking straw
- ✓ 1 Thin stir straw
- ✓ 3 Lids for 2 oz. portion cups
- ✓ Adhesive tape or glue
- ✓ Single hole punch
- ✓ Pencil to widen holes
- ✓ Marker or colored tape
- ✓ Weights, straps, or duct tape
- ✓ Time piece that measures seconds

This activity can be used to teach:

- Weather patterns (CA Science Standards: Grade 5, 4 a-d)
- Sun powers wind (CA Science Standards: Grade 6, 4.a)

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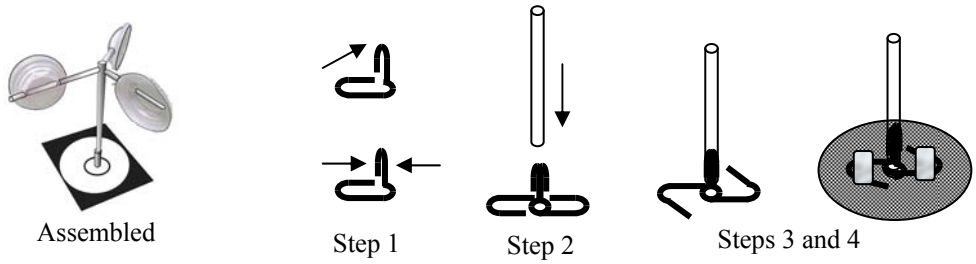
Catching the Wind

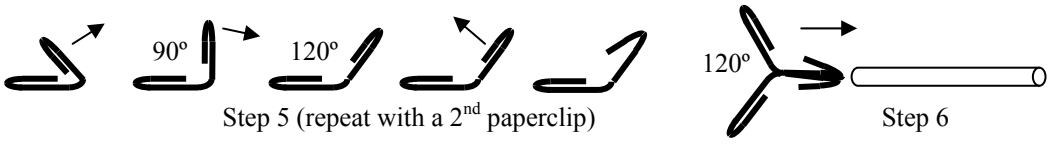
A mechanical device to gauge wind speed



Learn how an anemometer works and use one to make wind speed measurements.

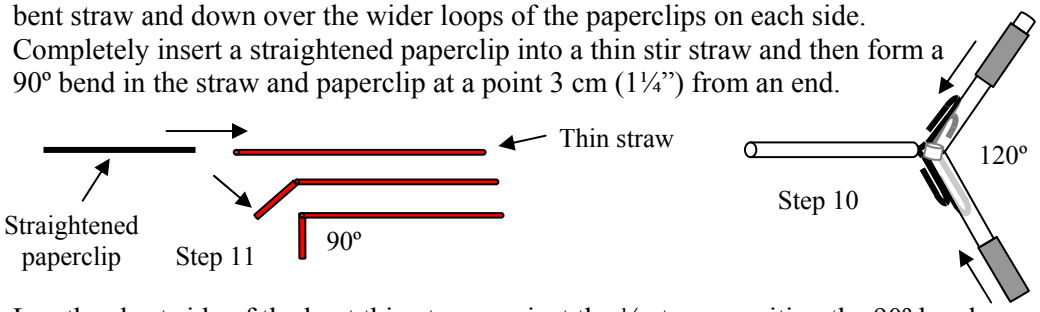
Assembly

1. Bend the narrower loops of 2 paperclips upward to a right angle (90º). Pinch the narrow loops to make them narrower.
2. Make an inverted "T" shape by inserting both paperclips' narrower loops into a small diameter straw so the wider loops are on opposite sides of the straw.
3. Bend out leg of the wider loops of the bent paperclips and place on a CD, or other suitable base, positioned with the narrower loops at the center.
4. Tape or glue the wider loops of the paperclips to the CD.
5. Cut a drinking straw in half. Only one of the halves will be used.
6. Take 2 more paperclips and bend the narrower loops up to a right angle (90º) and then 1/3 farther to make a 120º angle. Make the narrower loops slightly wider by bending a "leg" outward. Insert the bent narrower loops of both paperclips into a half straw so that the wider loops form a 120º angle to each.



7. Bend a paperclip to form an "S" shape as shown below.
8. Use a thin straw to push the "S" shaped paperclip into a drinking straw. Center the paperclip between the straw's ends. Bend the middle of the straw until a 120º angle is formed.

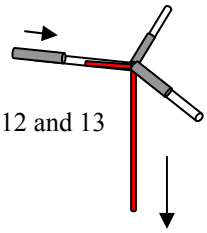
9. From a larger diameter straw cut 3 sections that are each 5 cm (2") long.
10. Place the middle of the bent straw into the 120º angle formed by the 2 bent paperclips from step 6. Slip a larger diameter straw section over each end of the bent straw and down over the wider loops of the paperclips on each side.
11. Completely insert a straightened paperclip into a thin stir straw and then form a 90º bend in the straw and paperclip at a point 3 cm (1¼") from an end.



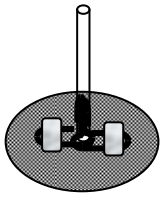
12. Lay the short side of the bent thin straw against the ½ straw; position the 90º bend at the center of the 120º angles. See the illustration on the next page.

Designed and written by Michael Pollock (RAFT)

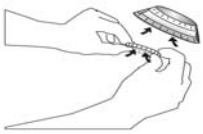
13. Slide the remaining 5 cm (2") long straw section over the ½ straw, capturing the short side of the bent thin straw. This creates the center pivot for the anemometer's 3 arms.
14. Place both thumbs on the inside center section of a portion cup lid while holding the outside edges with the other fingers. Push out with the thumbs, rotate the lid slightly, and repeat until the lid becomes dome shaped. Repeat with the other 2 lids.
15. Punch 2 holes on opposite sides of each domed lid as close as possible to the flat center section. An imprinted name, if present, can be used to guide creating holes 180º apart.
16. Insert a straw arm of the anemometer through the 2 punched holes of a domed lid. Repeat for the other 2 straw arms. Adjust the lids so each lid faces toward the back of the next lid, as shown on the first page. Use a pencil to widen the holes, if needed.



Steps 12 and 13



Step 17



Steps 14 to 16

(Only the anemometer's straw arm is being shown)

17. Insert the thin straw pivot into the straw attached to the CD base made in steps 1 to 4 on the previous page.
18. To facilitate counting rotations, uniquely mark one arm of the anemometer with a marker or colored tape.

To Do and Notice

1. Blow or fan air toward the anemometer to check that the lids (the anemometer's **cups**) rotate freely.
2. To generate test winds for practice measurements use a box fan with variable speeds (best) or other type fan. The anemometer and fan should be positioned in the same location for each measurement.
3. Place the anemometer in an exposed outdoor location and attach or weigh down the base to prevent tipping.
4. Count how many times the marked straw rotates during a set period of time (e.g., 10 seconds).
5. Repeat on different days and/or times to compare the relative speeds of any wind on those dates and/or times.
6. To measure wind speed in kilometers per hour (km/hr), calculate the distance a cup travels in one revolution. First measure the distance (R) from the center of rotation to the middle of the cup in centimeters. The formula for the distance traveled would be **D** = 2Rπ (where π is 3.14..) but for this simple instrument use D = 6R, where π is rounded to 3. A kilometer per hour wind goes about 30 cm in one second or roughly 300 cm in 10 seconds. If the number of revolutions counted during 10 seconds is **N,** then the wind speed, in km/hr, is [**N** times **D**] divided by 300. For an anemometer with a 10 cm radius the number of revolutions in 10 seconds divided by 5 will give an approximate wind speed (speed = **N**/5) in km/hr. Multiply by 0.7 for miles/hr.

The Science Behind the Activity

Wind speeds will vary at different heights above the ground (standard measurements are made 10 meters above ground/sea level) and at different times (hour, day, month, and year). Wind speeds of over 370 km/h (230 mph) have been recorded on Earth. Wind speeds in tornadoes and other atmospheric phenomena can be even greater, but they have never been accurately measured. Nearby landforms, buildings, and foliage will also affect ground winds. The anemometer's cups turn in one direction due to the number and shape of the cups. An anemometer with 4 evenly spaced cups would barely turn in a wind where as a 3 cup version would spin rapidly. With 3 cups spaced 120º apart, one cup will always be more strongly pushed in one direction than the other two cups are pushed in the opposite direction. In a 4-cup design – the forces might balance and cancel out. Additionally a half spherical shaped cup offers more resistance to air movement coming toward the open end than air coming from the rounder back of the cup.

Web Resources (Visit www.raft.net/more for how-to videos and more ideas!)

- Basic wind measurement details and conversion for wind speed at other heights - www.uwsp.edu/cnr/wcee/keep/Resources/Agriculture/Activitiespdfs/Ag%20Ed%20Measuring%20Wind%20Speed.pdf
- Wind speed over water issues and indicators - www.pangolin.co.nz/almanac/true_wind.php#Estimating%20Wind%20Speeds%20Without%20Instruments
- Wind speed measurement based on foliage deformity - http://extension.oregonstate.edu/catalog/pdf/ec/ec1163-e.pdf