RAFT IDEAS

Topics: Apparent Motion of Sun, Solar Time, Scientific Investigation

Materials List

- ✓ Non-flexible drinking straw
- ✓ View binder cover (clear pocket on the outside), 29 x 28 cm (11” x 11½”)
- ✓ Paper or cardstock, 22 x 28 cm (8½” x 11”)
- ✓ Paperclip
- ✓ Tape
- ✓ Compass, magnetic
- ✓ Meter stick
- ✓ Dry-erase marker
- ✓ Watch
- ✓ Data table (page 2)

This activity can be used to teach:

- Sunlight can be blocked to create shadows (CA Science Standards: Grade 3, 2.a)
- Position of the Sun in the sky changes (CA Science Standards: Grade 3, 4.e)
- Identify changes in natural phenomena over time (CA Science Standards: Grade 6, 7.h)

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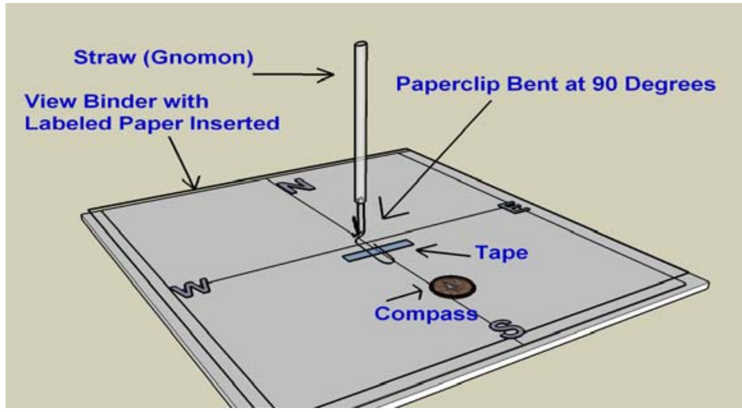
View Binder Sundial

Tracking the Sun’s Movement Using an Ancient Method



Sundials are ancient tools that can be used to estimate local solar time and investigate the apparent position of the Sun in the sky.

Assembly

1. Fold the paper or cardstock in half lengthwise, then widthwise; unfold.
2. Lay the paper on a smooth flat surface. Draw lines along the two folds to make a pair of intersecting lines.
3. Make a compass rose by labeling opposite ends of the lines as **N** (north), **S** (south), **E** (east), and **W** (west) as shown. Make sure the labels correspond to the positions of the cardinal directions.
4. Insert the paper, labeled side up, into the pocket of the binder cover.
5. Place the binder cover, pocket side up, on a flat surface.
6. Bend the narrow “inside” loop of a paperclip so that it forms a right angle with the wider loop. Place the paperclip on the binder so that the wide loop points along one of the drawn lines and the narrow loop projects vertically from the lines’ intersection. Tape the wide loop to the binder.
7. Put a straw over the narrow end of the paperclip. Note: the straw should be vertical and fit tightly over the paperclip. Make adjustments as needed.
8. Tape a small magnetic compass to the view binder such that the **N-S** tick marks on the compass align with the **N-S** line of the compass rose.

To Do and Notice - (Note: Measurements should be taken when the sundial is in sunlight - either outside or near a sunny window. As data will be taken over the course of the day and over several days, mark the location to assure identical placement for future data recording)

1. The paperclip and straw form the gnomon of the sundial, which casts the shadow used to tell time. Measure the height of the gnomon. Record in the data table.
2. Use the compass to position the sundial on a flat level surface so that **N** is pointing north.
3. Make a dot at the end of the gnomon’s shadow with a dry erase marker.
4. Measure and record in the data table the distance from the base of the gnomon to the dot and the time the measurement was taken. Label the dot with the time.
5. Measure and record the distance from the top of the gnomon to the dot.
6. Take 3-5 measurements, at least one hour apart, during the day. Record all measurements and times.

Written and illustrated by Eric Welker (RAFT)

7. Identify the dot closest to the gnomon. This is the time of the shortest shadow and is the observation taken closest to local solar noon.
8. On the following day, around noon, observe the shadow being cast by the gnomon and estimate the current time using the previously day's data. Compare the estimate to the actual time.

The Science Behind the Activity

Many ancient cultures used sundials to determine the optimum times for planting crops, building settlements, and to better understand astronomy. Some countries such as Japan and China still use sundials as the main time pieces in government buildings.

Over the course of the day the shadow cast by the gnomon changes in length and direction. As the Earth rotates about its axis the sun appears to be moving across the sky for the observer. As the sun's apparent position changes, so does its elevation above the horizon. The length of the shadow cast by the gnomon will be longer when the sun is lower in the sky and shorter when the sun is higher in the sky. The shortest shadow during a particular day of observation is the closest approximation to local solar noon for a specific location on the Earth. Observations made in a period of 1-2 weeks can be used to make reasonable estimates of local time. During longer periods of time (e.g. months) the estimates will be less accurate when compared to the initial observations because the Earth revolves around the sun, which further alters its apparent position in the sky.

Taking it Further

- See RAFT Idea Sheet ***A Time for Shadows*** for an activity on determining accurate local time.
- Explore how the sun's daily path varies with the seasons; see RAFT Idea Sheet ***Solar Path Across the Sky***.
- Use the recorded data, the height of the gnomon, and the geometry of similar triangles to determine the angle of the sun above the horizon for each marked dot on the sundial.

Web Resources

- History of the sundial - http://www.indwes.edu/Faculty/bcupp/things/Greenwich/Sundials.html and http://www.hps.cam.ac.uk/starry/sundials.html

Date _______________ Height of Gnomon (cm)______________

Time	Length of shadow cast by gnomon (cm)	Distance between top of gnomon to end of shadow (cm)

Estimated time of solar noon ____________

Date	Length of gnomon's shadow (cm)	Estimated time	Actual time