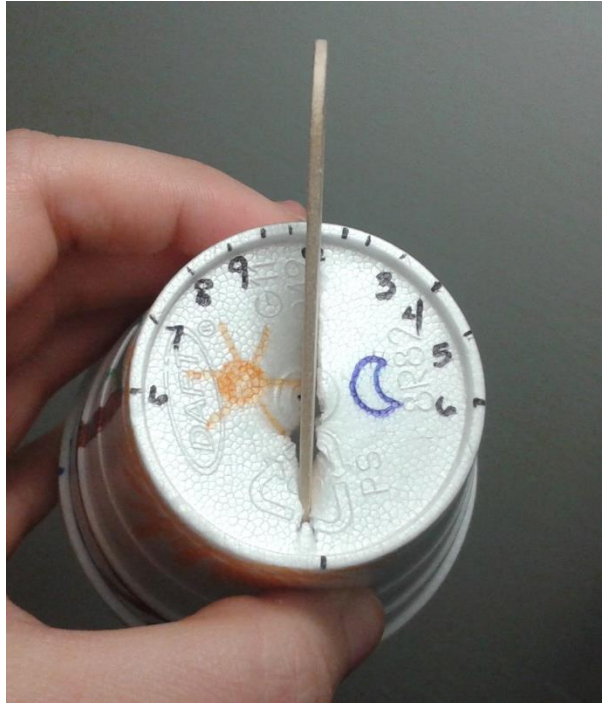


Sundials

Telling Time with Earth's Orbit and Axial Tilt

Designed for 4th Graders



Educational Goals

1. Students explore how shadows change over the course of a day and a year due to Earth's orbit and axial tilt
2. Students connect to Earth's orbit, axial tilt, and seasons by exploring their effects on their day to day experiences
3. Students learn about the history of telling time

Materials

Flashlight
Globe of the Earth
Globe of the Moon (optional for comparison to Earth)
Styrofoam cups (one per student)
Skinny wooden art sticks or tongue depressors (one per students)
Sharpies
Handout: "Instructions for Knoxville Tennessee"

Lesson Outline

Introduction and Video

- Earth's Orbit Video (<https://www.youtube.com/watch?v=l64YwNI1wr0>) – recommend stopping when she starts talking really quickly about the globe and lamp activity

Short drawing activity

- Using plane paper and pencils, participants draw a picture of themselves and their shadow
- *Does your shadow look like you? How? How not?*
- *Does your shadow always look the same?*

Video and Interactive demonstration

- Shadows and Time video (<https://www.youtube.com/watch?v=1SN1B0pLZAs>) – show full video
- With globe and flashlight, demonstrate the Sun and Earth's relative position for winter and summer – include axial tilt (23.5° from vertical) demonstrating the Sun's apparent track above and below the equator
- *Are our shadows the longest in summer or winter?*
- *What does this mean for Alaska? Antarctica? The Caribbean?*
- Optional: *The Moon's axis doesn't tilt very far. What does this mean for shadows on the Moon? At the equator? At its poles?*

Introduction to sundials

- Explain what sundials are. They have been around for over 2000 years. They can tell you the time of day. They need to be calibrated for your location (latitude: Knoxville is $\sim 36^{\circ}$ N) to work.
- Demonstrate how shadows move across an example completed sundial using the flashlight. Explain how they can setup their sundials in a sunny location at their homes and know the time!

Construction of the sundials (follows the instructions outlined in "Instructions for Knoxville TN")

- Student design and color their foam cups and tongue depressors using the sharpies. They should NOT color the bottom of the cup – this will be the top of their sundial. Once they are done designing and coloring their sundial and gnomon (the tongue depressor), the instructor uses the protractor to mark the locations of the hours. The students can then choose to design the top of their sundial around the numbers.

Wrap-Up

- Instructor summarizes the lesson (e.g., with leading questions) and reminds students how to set their sundials at home. The instructions for the sundial are given to the students for future reference. This document is titled "Instructions for Knoxville TN".