Understanding and Building a Sundial

Exploring Timekeeping with Shadows

# Lesson Overview

This lesson introduces middle school students to the concept of sundials, an ancient method of timekeeping that uses the position of the sun and the resulting shadows to tell time. Through hands-on activities and engaging discussion, students will explore how sundials work, their significance throughout history, and how to construct a simple sundial using everyday materials.

# Learning Objectives

* Understand the basic principles behind sundials and how they measure time.
* Explain the science of shadows and the sun’s apparent movement across the sky.
* Describe the historical significance of sundials across different cultures.
* Design and build a simple, functional sundial.
* Analyze how the position of the sun affects shadow length and direction.
* Reflect on the advantages and limitations of sundials compared to modern timekeeping devices.

# Materials Needed

* Paper plates or cardboard circles (one per student or group)
* Sharpened pencils or drinking straws (for gnomons)
* Sticky tack or modeling clay
* Markers or colored pens
* Protractors and rulers
* Compasses (to find North)
* Watches or digital clocks for comparison
* Outdoor area with sunlight
* Notebook or worksheet for observations

# Lesson Duration

* Class Period 1: Introduction and Exploration (45 minutes)
* Class Period 2: Building and Testing Sundials (45 minutes)
* Optional Extension: Long-term Shadow Tracking and Analysis

# Lesson Procedure

## Class Period 1: Introduction and Exploration

1. Warm-Up (5 minutes)

* Start with a question: “How did people tell time before clocks and watches?” Allow students to brainstorm and share ideas.
* Discuss responses, guiding them towards natural methods of timekeeping, especially using the sun and shadows.

2. Direct Instruction (10 minutes)

* Present a brief history of sundials, emphasizing their use in ancient Egypt, Greece, Rome, and China.
* Explain key terms: gnomon (the part of a sundial that casts a shadow), dial (the surface with hour marks), and solar noon (when the sun is highest in the sky).
* Introduce the science: The sun appears to move across the sky due to the Earth’s rotation, causing shadows to move and change length.

3. Demonstration: Shadow Tracking (10 minutes)

* Take students outside, or simulate with a lamp and pencil indoors if needed.
* Place a pencil upright on the ground and ask students to observe the shadow’s length and direction.
* Mark the tip of the shadow and note the time. If possible, repeat this at intervals throughout the day or watch a time-lapse.
* Discuss: “Why does the shadow move and change?”

4. Group Discussion: The Sun’s Path (10 minutes)

* Ask: “Why is the sun’s path important for telling time with shadows?”
* Illustrate how Earth’s tilt and rotation affect the apparent movement of the sun and the length of days.
* Connect to seasons and geographic location: Sundials are accurate only when set up correctly for their location.

5. Introduction to Sundial Design (10 minutes)

* Show different types of sundials (images or models): horizontal, vertical, equatorial, and portable sundials.
* Discuss how they all use shadows to tell time, but are designed differently depending on location and purpose.

## Class Period 2: Building and Testing Sundials

1. Review and Setup (5 minutes)

* Recap key points from the previous session and explain the activity: building a sundial.

2. Sundial Construction (20 minutes)

* Distribute materials to students or groups.
* Instructions:
* Draw a circle on the paper plate or cardboard to represent the sundial’s face.
* Find the center and create a small hole for the gnomon (pencil or straw).
* Attach the gnomon vertically with sticky tack or modeling clay.
* Use a compass to find North, and orient the sundial so the gnomon points true North (in the Northern Hemisphere).
* Mark the current hour by noting the position of the shadow and writing the time on the dial.
* If time allows, students can decorate the dial and add marks for additional hours as the day progresses.

3. Testing the Sundial (15 minutes)

* Take sundials outside to a sunny spot.
* Students observe the shadow throughout the period, marking the tip at set intervals (e.g., every 10–15 minutes).
* Record observations in notebooks: time, shadow length, shadow direction.

4. Analyzing Results (5 minutes)

* Back in class, discuss findings as a group.
* Questions for reflection:
* How did the shadow move as the sun moved across the sky?
* Was the sundial accurate compared to a clock? Why or why not?
* What factors affected the accuracy of your sundial?

5. Wrap-Up and Homework (5 minutes)

* Summarize what was learned about sundials, shadows, and the sun’s movement.
* Assign homework: Students can leave their sundials outside for a day or two, recording hourly shadow positions and comparing their sundial to a clock.

# Differentiation Strategies

* For advanced students: Challenge them to calculate the angle of the gnomon based on latitude, or research and present on sundials in different cultures.
* For students who need more support: Provide templates for the sundial face, visual step-by-step guides, or pair them with a peer buddy for construction.
* For hands-on learners: Incorporate more outdoor observation and repeated measurements.

# Assessment

* Participation in discussions and group work.
* Completion and functionality of the constructed sundial.
* Accuracy and detail in observation records.
* Responses to reflection questions and class discussion.
* Optional: Short quiz on sundial terminology and the science of shadows.

# Extension Activities

* Research different types of ancient timekeeping devices and create a presentation or poster.
* Compare the sundial’s readings over several days and analyze discrepancies due to weather, daylight saving time, or shadow length.
* Explore the use of sundials in navigation and architecture.
* Investigate how sundials must be adjusted for different locations around the world.

# Background Information for Teachers

Sundials work because the Earth rotates on its axis. As the sun appears to move from east to west across the sky, the shadow cast by the gnomon shifts accordingly. By carefully marking the positions of the shadow at known times, a sundial’s face can be calibrated to display the correct time—at least for its specific location and time of year. However, sundials are subject to certain limitations: cloud cover, differences in latitude, and daylight saving time can all affect accuracy. Even so, they remain an excellent tool for introducing students to the movement of celestial bodies, the science of shadows, and the history of timekeeping.

# Conclusion

In this lesson, students gain firsthand experience with designing and using a sundial, connecting abstract concepts in science and history to real-world observation and experimentation. By the end, students will have a deeper appreciation for ancient ingenuity and the natural rhythms that govern our sense of time.