

Sundial Maker Kit Curriculum

Lesson 01: Investigating Shadows

Goal(s): To introduce students to the concept of shadows and show how they can change throughout the day (a pre-introduction to the sundial clock and how it measures time)

Guiding Question(s): What is a shadow? How do shadows form? Do your shadows change throughout the day?

Vocabulary: Shadow

Materials: Post-it Notes, “What Will Your Shadow Look Like?” Handout, My Shadow Recording Sheet, Sidewalk Chalk, Tape Measure (optional), Flashlight (optional)

Estimated Time: 45-60 Minutes (throughout the span of a day)

Launch

1. **Morning Meeting Conversation:** What is a shadow? How do shadows form?
 - a. Ask students to think about shadows—where have they seen shadows and how shadows are created.
 - b. Watch the YouTube video of [Moonbear's Shadow](https://www.youtube.com/watch?v=DaBNagX1meY) by Frank Asch (Sundial Teacher Deck; Day 01, Slide 03)
 - i. (**Link:** <https://www.youtube.com/watch?v=DaBNagX1meY>)
 - c. Pass out the *What Will Your Shadow Look Like?* handout (Sundial Student Handouts; Day 01, Slide 04) and ask students to draw themselves and what they think their shadow would look like.
 - d. Explain to students that they will observe their shadows three times throughout the day. Ask the children if they think their shadows will be the same each time they observe. Have students record their Yes/No responses on a Post-it note. When students have recorded their responses collect them, and have students THINK-PAIR-SHARE why they think their shadows would/would not be the same each time.
 - e. Discuss students' predictions and have them represent the data on a T-chart (tally marks) and as a "Bar Graph" (Sundial Teacher Deck; Day 01, Slides 05-06) as a class.

Explore

2. **Exploration (throughout the day)**
 - a. Pass out and display on the board the *My Shadow Recording Sheet* (Sundial Teacher Deck; Day 01, Slide 07 AND Sundial Student Handout; Day 01, Slide 06) and show students the materials they will use to represent their shadows (e.g., sidewalk chalk) on the concrete outside. Model how to record the information on their sheet.
 - i. Discuss the different times throughout the day that they will observe their shadows: (e.g., 10:30, 12:30, 2:30). Show students the digital and analog clocks on the recording sheet and ask the students how they would represent the times on the clock. Emphasize the position of the minute hand and hour hands on the analog clock and the minutes and hours in relation to the colon on the digital clock.
 - b. Explain to students that they will pair up with their elbow partners and take turns recording their shadows.
 - i. Demonstrate how the children will mark an x on the concrete and stand on the x. Then, their partner will trace the shadow on the concrete using the sidewalk chalk. The partners will switch roles. You may want to use different colors of chalk for each student. Students will record the time on both the analog and digital clocks and sketch their shadows.

- c. Review the directions and expectations at each time of day. Remind students they should face the same direction and stand in the same position each time. Pair up the students and distribute the recording sheets and chalk. Have students work on the My Shadow Recording Sheet throughout the day.
 - i. At later times during the day, prompt children to make observations about the size and position of the shadows before recording them on their sheets. Ask the children to think about how they can represent their shadows on the recording sheet and how they can accurately demonstrate the differences between the shadows at different times of the day.
 - 1. Monitor as students record their shadows and highlight the size and position of the shadow as well as the shape.
 - 2. As an extension, have students measure the length of their shadows.

Summary

- 3. End of the day—following the last shadow recording
 - a. Ask students what they noticed about their shadows. Revisit the poll at the beginning of class about whether students believed their shadow would stay the same throughout the day.
 - b. Ask students how (or why) their shadow changed.
 - c. Ask students to predict how their shadows would be different early in the morning or late in the evening. Prompt students to think about how the time of day and the size/position of the shadows follow a pattern.
 - i. Ask children to THINK-PAIR-SHARE the following :
 - 1. *What is the light source that created our shadows?*
 - 2. *How did our shadows change position?*
 - 3. *How did our shadows get longer or shorter?*
 (If students need additional prompting, use a flashlight to show students how the size and the position of an object’s shadow change based on the position of the light source.)
 - d. Prompt students to think about the pattern in the size/position of the shadows and the connection to night and day.
 - e. Ask the students if they think they could use shadows to tell time. Ask students the following prompts:
 - i. *What devices do you use to measure time?*
 - ii. *How do the devices we use to measure time work?*
 - iii. *Which tools do you think are the most accurate for recording how time passes? Why?*
 - iv. *Is there a time-measuring device that uses shadows to tell time? (We will elaborate more on this in the next lesson)*

Lesson 02: The Sundial Clock

Goal(s): Introduce students to the sundial clock and its functions. To build the Sundial Maker Kit. To learn about Roman numerals.

Guiding Question(s): What is a Sundial Clock? How Does a Sundial Clock Work? What are Roman Numerals?

Vocabulary: Sundial, Roman Numerals

Materials: Sundial Clock Maker Kit, Labyrinth Escape! Handout, Color by Numbers Handout

Estimated Time: 45 - 60 Minutes

Launch

1. Ask students where they think time-telling came from. Ask students what they think time zones are and why they think we have so many of them.
2. Have students watch [The History of Keeping Time](#) video by TED-Ed (Sundial Teacher Deck; Day 02, Slide 10). Ask students what they learned about time from the video.
3. Ask the students if they have ever noticed how the sun seems to move across the sky. Discuss how we identify times of day as sunrise and sunset. Ask the students to THINK-PAIR-SHARE,
 - a. Does the sun move? Does the sun actually rise or set each day? What is causing the rotation?
4. Review and explain that the sun looks like it is following a path in the sky, but it is actually the Earth that is moving. Discuss how the Earth rotates on its axis and that one full rotation (360 degrees) indicates one full “solar day”.
 - a. Explain that the early Egyptian astronomers made similar observations and developed a device to help them identify patterns and document the movements. These devices were called *sundials*. *Sundials* are used to indicate the position of the sun and can be used to estimate the time of day. Tell students that as the Earth rotates, the shadow created by the sundial indicates the time of day.

Explore

5. Pass out the Sundail Maker Kits. Explain to students that in their groups, they will use the materials in their kits to construct a sundial (Sundial Teacher Deck; Day 02, Slides 11-21)
 - a. Once students have finished building the sundial, have them identify the parts of the sundial. Sundials include:
 - i. A dial or faceplate
 - ii. A gnomon, an object casting the shadow
 - iii. An angle indicator a support that will read off the latitude (angle) the gnomon is at. To place the sundial at the correct latitude angle, find the correct latitude for your current location and rotate the sundial accordingly.
 - b. Show the brief video (0:38) with a voiceover discussing the position of the shadows based on the time of day (Sundial Teacher Deck; Day 01, Slide 22).
 - i. Ask the students what they noticed as they watched the video.
 - ii. What similarities do they see to the My Shadow activity from the previous day?
 1. When are shadows the longest? When are they the shortest?
 2. Why do you think the length of the shadows is the longest, early in the morning or right before dusk?
 3. Why is it the shortest shadow at noon?
 4. What direction do the shadows move?

- a. Do you notice a pattern with the length and direction of the shadows?
5. Do you think the shadows would move in the same way in different places around the world? Why?
- c. Ask students to predict what the shadows would look like at different times of the day based on their shadow experiences from the previous day. Record their ideas on the board.
 - i. NOTE: Try to go outside at the same time as one of the times recorded on Day 01 My Shadow.
- d. Go outside, place the sundial so that the gnomon is facing NORTH, and mark the position of the shadow on the sundial. Then, return inside and record the time of day. Make comparisons between the My Shadow activity from Day 01 and the sundial.
 - i. What do you notice about the shadows at the same time of day?
 1. How are they similar? How are they different?
 - ii. Do you think the shadows cast by any object would be in the same position at the same time every day? Why or why not?
- e. Discuss how to read the sundial. Inform students that most sundials use Roman Numerals (but in this case, its Arabic Numerals, and you use the dial to read the approximate time).
 - i. Tell students when writing Roman Numerals, I is one, V is five, and X is ten. Explain that all the numerals 1 - 12 (Arabic Numerals) will be written only using the letters I, V, or X.
 - ii. Have students record these Roman Numerals on their Writing Like Romans handout (Sundial Student Handout; Day 02, Slide 09).
 - iii. Explain to students that the Roman Numeral represents quantities or numbers. Explain that like in our numeral system, the position of the numbers is important. For example, in the Roman Numeral IV, the position of the I and V tells you IV represents 1 number *before* 5 (so it's 4).
 - iv. Ask students to turn and talk to their elbow partner and discuss how to represent the number 6 using Roman Numerals. Remind students to think about the meaning of the V and the I and the position of the letters (VI is one AFTER five, so 6).
 - v. Ask students to work in their groups to complete the Writing Like Romans handout.
 - vi. For further review (as needed), have students complete the Labyrinth Escape! Handout and the Color by Numbers Handouts (Sundial Student Handouts; Day 02, Slides 11,13,15).