

Sundial Wristwatch: 5.B.1

Grade Level	5
Sessions	1 – approximately 60 minutes
Seasonality	N/A
Instructional Mode(s)	Whole class
Team Size	N/A
WPS Benchmarks	05.SC.ES.01 05.SC.ES.02 05.SC.ES.03 05.SC.TE.06 05.SC.TE.07
MA Frameworks	3-5.ES.14 3-5.TE.1.1 3-5.TE.1.2 3-5.TE.2.3
Key Words	circumference, diameter, gnomon, north latitude, North Pole, radius, shadow, sun

Summary

The students will learn about the sun and shadows by building a sundial wristwatch.

Learning Objectives

2002 Worcester Public Schools (WPS) Benchmarks for Grade 3-5

Earth/Space Science

05.SC.ES.01 – Recognize that the earth revolves around (orbits) the sun in a year's time and that the earth rotates on its axis once approximately every 24 hours.

05.SC.ES.02 – Make connections between the rotation of the earth and day/night, and the apparent movement of the sun, moon, and stars across the sky.

05.SC.ES.03 – Observe and discuss the changes in length and direction of shadows during the course of the day.

Technology/Engineering

05.SC.TE.06 – Identify relevant design features (i.e., size, shape, weight) for building a prototype of a solution to a given problem.

05.SC.TE.07 – Compare natural systems with mechanical systems that are designed to serve similar purposes, i.e., a bird's wings as compared to an airplane's wings.

Additional Learning Objectives

1. At the conclusion of this lesson, the students will be able to determine how to tell time without modern day clocks and watches.
2. At the conclusion of this lesson, the students will be able to explain how sundials function through the use of the sun.
3. At the conclusion of this lesson, the students will be able to determine under what conditions sundials work the best and under what conditions they don't work and why.

Required Background Knowledge

1. A basic understanding of the engineering design process

Essential Questions

1. How does the sun's direction change the length and direction of shadows?

Introduction / Motivation

Ask the students to imagine that they lived 1000 years ago. They have arranged to meet a friend in the village square for a day of shopping. How would they arrange to meet so that both friends would be on time and neither one would be kept waiting. Mechanical clocks and watches have not been invented. Have the students brainstorm about how to use the sun and shadows to find a solution. Students will also complete a worksheet, *What Time Is It ?* (attached), at the conclusion of the lesson.

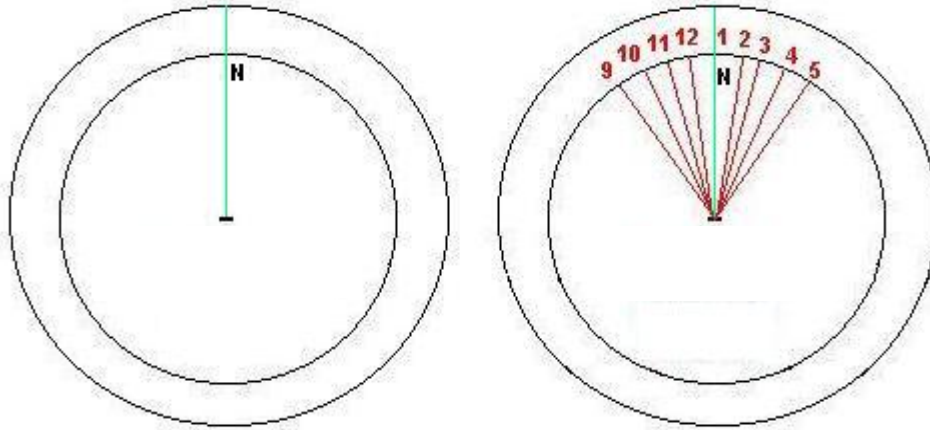
Procedure

The instructor will read through the following instructions with the students or use sundial template (attached) at their discretion:

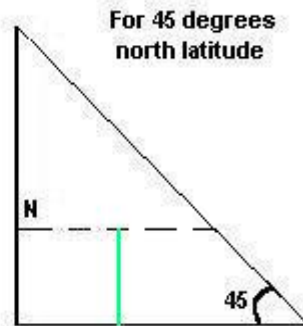
1. After explaining the introduction problem for this lesson and what a sundial is and how it is used, have the students brainstorm ways that they could make a

portable sundial they could carry with them. Have them explain their ideas on the **Brainstorm Worksheet**.

2. Draw a circle with a 2.5 cm diameter for the watch face. Draw a radius and mark it with "N" for North. Draw 4 lines on either side of the N. Each section should form an approximately 11 degree angle. Mark the numbers as shown.

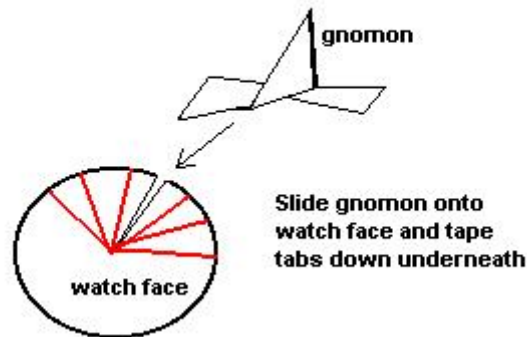


3. Draw a right triangle for the gnomon. The other 2 angles should be 45 degrees each. The dimensions of the triangle should be as shown. Draw the lines on the triangle as shown.

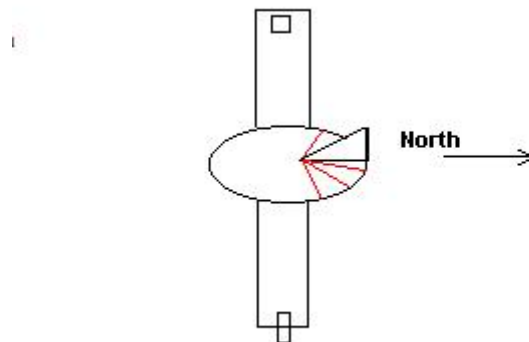


4. Cut a wristband piece 2 or 3 cm wide (about 1 inch) and 1.5 times the circumference of your wrist.
5. Cut into the watch face and gnomon along the green lines.
6. Fold the gnomon along the dashed line.

7. Slide the gnomon onto the face's slit, folding the two underneath pieces to opposite sides. Make sure the side of the gnomon that is going STRAIGHT UP&DOWN (vertical) is by the outer edge of the watch face.



8. Tape down the flaps under the watch face, trimming the extra from the flaps.
9. Tape the watch to the wristband with the vertical edge of the gnomon pointing toward the short side of the wrist band (see diagram).
10. Put your sundial watch on your wrist and tape the ends together.



To Use your Sundial Watch:

With the watch on your **LEFT ARM**, go outside and face **WEST**, holding your arm with the watch level in front of you so that the vertical edge of the gnomon is pointing **NORTH**. (If you don't have a compass handy you can usually estimate north since many buildings are oriented to north/south.) Read the approximate time by the number the shadow falls nearest to.

Materials List

Materials per class	Amount	Location
Heavy construction paper	Two pieces / student	Craft Store
Compass (to find north)	Eight	Craft Store or
Compass (to draw circles)	Eight	Craft Store or Office Supply Store
Protractor	Eight	Craft Store or Office Supply Store
Ruler	One / student	Craft Store, Supermarket or Office Supply Store
Scissors	One / student	Craft Store, Supermarket or Office Supply Store
Tape	Depends on students' needs	Craft Store, Supermarket or Office Supply Store

Materials per student	Amount	Location
Sundial Template	One / Student	Attached to lesson plan
Student Directions	One / Student	Attached to lesson plan

Vocabulary with Definitions

1. *Circumference* - the length of the closed curve of a circle
2. *Diameter* - the length of a straight line passing through the center of a circle and connecting two points on the circumference
3. *Gnomon* - a vertical pointer that will indicate noon correctly when its shadow points north
4. *North Latitude* - the angle between the North Star and the base of the sundial
5. *North Pole* - the north end of the axis of rotation of the earth or any astronomical object
6. *Radius* - the length of a line segment between the center and circumference of a circle or sphere
7. *Shadow* - a dark shape cast on a surface caused by an object blocking light
8. *Sun* – the star at the center of our solar system around which the earth and eight other planets rotate

Assessment / Evaluation of Students

The instructor may assess the students in any/all of the following manners:

1. Check the **What Time Is It?** worksheet at the end of lesson for participation and general knowledge.

Lesson Extensions

None

Attachments

1. Student Directions
2. Brainstorm Worksheet
3. What Time Is It? work sheet
4. Gnomon Template
5. Watch Plate Template
6. Complete Sundial Template

Troubleshooting Tips

Make sure the students are able to measure and draw using a ruler, protractor and compass. If not, the teacher can print out templates that the students can cut out instead of drawing them. The project should be done on a sunny day.

Safety Issues

None

Additional Resources

<http://kyes-world.com/sunwatch2.htm>

Key Words

Circumference, diameter, gnomon, north latitude, North Pole, radius, shadows, sun

Name _____

Brainstorm Worksheet

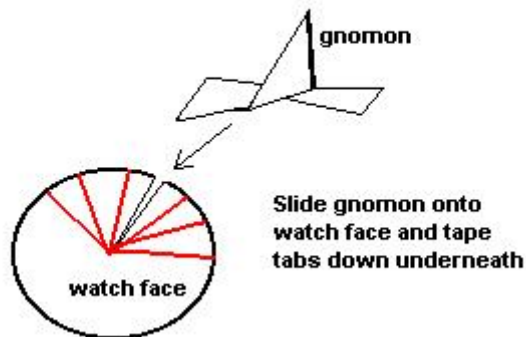
How could you make a portable sundial you could carry with you incase of emergencies.

Write a description your portable sundial device.

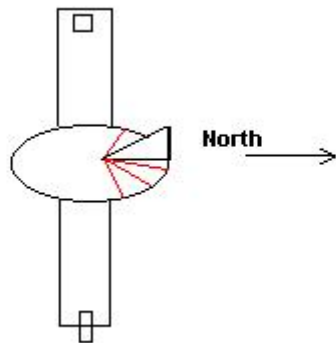
Draw a sketch of your device.

Student Sundial Wristwatch Directions

- 1) Cut into the watch face and gnomon along the green lines
- 2) Fold the gnomon along the dashed line.
- 3) Slide the gnomon onto the face's slit, folding the two underneath pieces to opposite sides. Make sure the side of the gnomon that is going STRAIGHT UP&DOWN (vertical) is by the outer edge of the watch face.



- 4) Tape down the flaps under the watch face, trimming the extra from the flaps.
- 5) Tape the watch to the wristband with the vertical edge of the gnomon pointing toward the short side of the wrist band (see diagram).
- 6) Put your sundial watch on your wrist and tape the ends together.

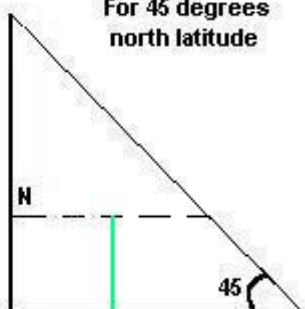


To Use your Sundial Watch:

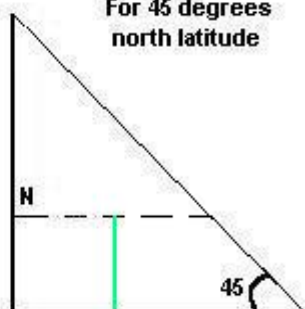
With the watch on your LEFT ARM, go outside and face WEST, holding your arm with the watch level in front of you so that the vertical edge of the gnomon is pointing NORTH. (If you don't have a compass handy you can usually estimate north since many buildings are oriented to north/south.)

Read the approximate time by the number the shadow falls nearest to.

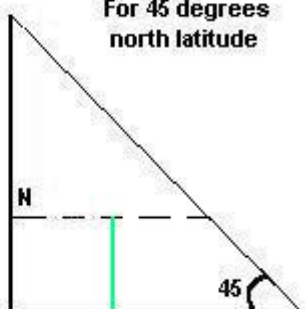
For 45 degrees
north latitude



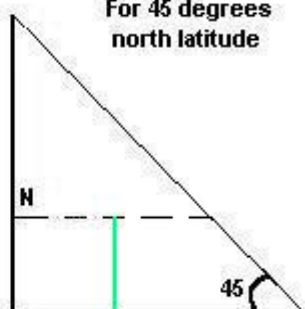
For 45 degrees
north latitude



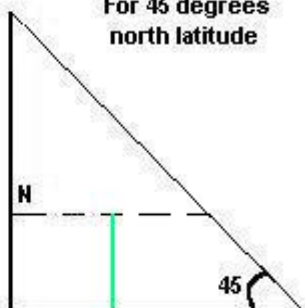
For 45 degrees
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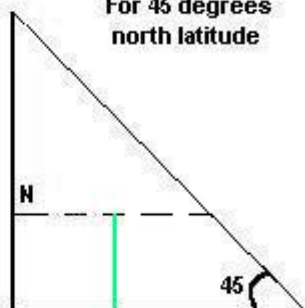
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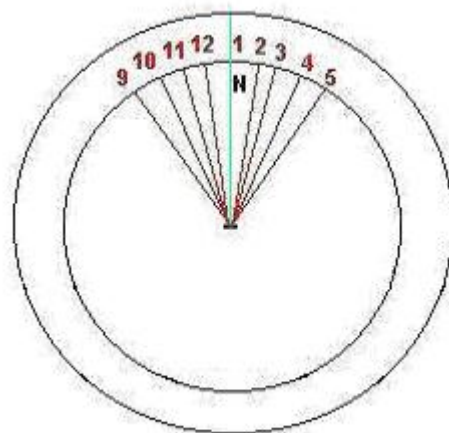
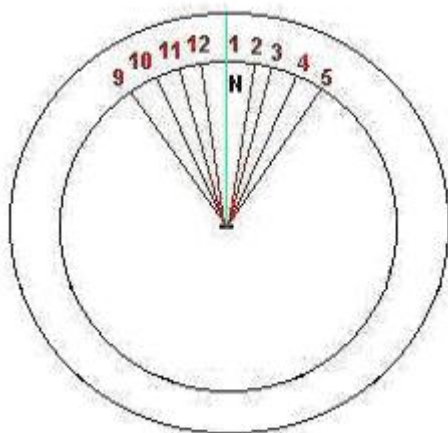
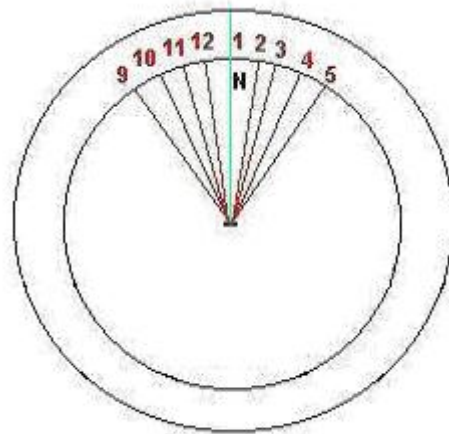
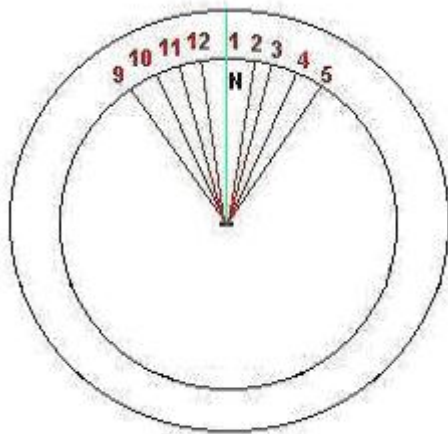
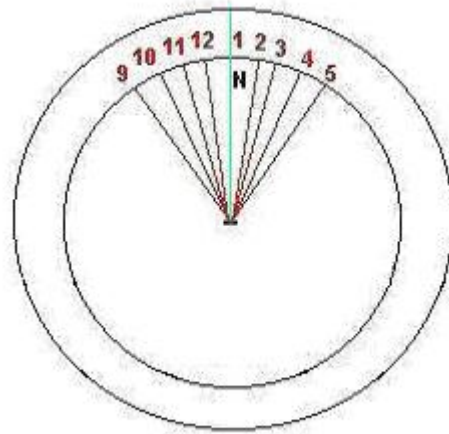
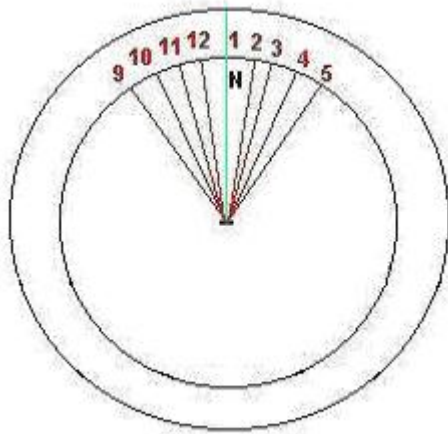


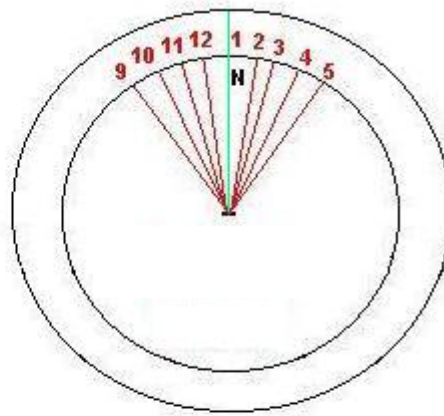
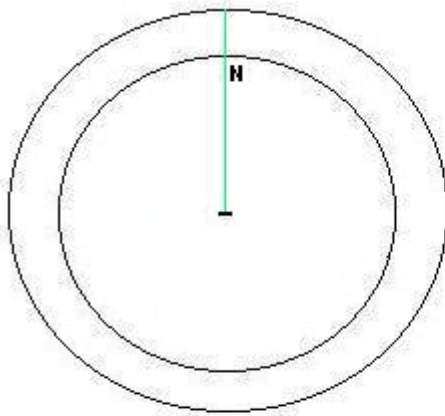
For 45 degrees
north latitude



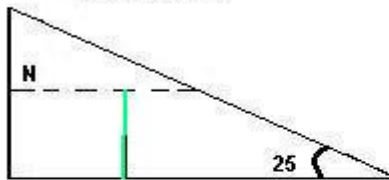
For 45 degrees
north latitude



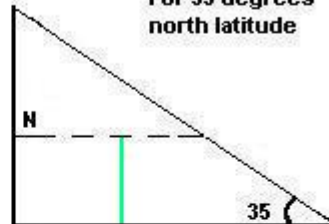




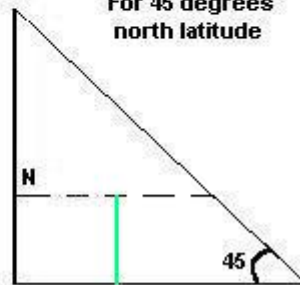
For 25 degrees
north latitude



For 35 degrees
north latitude



For 45 degrees
north latitude



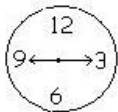
What Time Is It?

Long before the invention of the watch or the clock, people made up ways to mark the passage of time. One way was for a person to watch the length of his shadow. At dawn, his shadow was very long. The closer it got to noon, the shorter the shadow became. Then during the afternoon, his shadow began to grow longer and longer. At sunset it was exactly the same length as at sunrise.

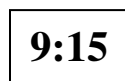
The invention of the sundial was based on the same idea. A sundial has a metal post pointed straight up. As the sun moves, the shadow moves. A sundial has special markings to tell the minutes and hours of the day. However sundials cannot help us keep track of time at night or on dark, cloudy days.

Modern day clocks and watches tell us the time - night and day, rain or shine.

There are two kinds of watches and clocks: analog and digital. Analog clocks show the hours and minutes of the day on the perimeter (or around the edge) of a circle. Two hands rotate around a point in the center and we tell time according to their positions on the circle.



Analog clock



Digital clock

Digital clocks are easier to read. Digital clocks show the hour and minutes in digital form; the hour and the minutes appear as numbers, separated by a colon(:).

Years ago, all analog clocks and watches needed to be wound regularly. Today most analog and all digital timepieces are battery-operated. Many people believe that analog clocks and watches are old-fashioned and will soon become a thing of the past.

Answer the following questions:

1. Before the invention of modern day clocks and watches, how did people tell time?

2. How do sundials work? Why are sundials useless at night?

3. What kinds of watches and clocks are available today? Which is easier to read? Why?

4. In your opinion, do you think children still need to learn to read both kinds of clocks?