**Sundial – Mathematics content**

Novice:

* Understand the concept of time (reading a clock)
	+ Tell and write time.

[CCSS.MATH.CONTENT.1.MD.B.3](http://www.corestandards.org/Math/Content/1/MD/B/3/)
Tell and write time in hours and half-hours using analog and digital clocks.

[CCSS.MATH.CONTENT.3.MD.A.1](http://www.corestandards.org/Math/Content/3/MD/A/1/)
Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.

* Understand that time is connected to the earth’s movement around the sun (e.g. one year is equal to one revolution and one day is equal to one rotation)
* Build a basic sundial and recognize the movement of the shadow of the gnomon

Intermediate:

* Construct a sundial based on the latitude of the city you’re in
* Geometric measurement: understand concepts of angle and measure angles.
	+ [CCSS.MATH.CONTENT.4.MD.C.5](http://www.corestandards.org/Math/Content/4/MD/C/5/)
	Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:

* + [CCSS.MATH.CONTENT.4.MD.C.5.A](http://www.corestandards.org/Math/Content/4/MD/C/5/a/)
	An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles.

* + [CCSS.MATH.CONTENT.4.MD.C.5.B](http://www.corestandards.org/Math/Content/4/MD/C/5/b/)
	An angle that turns through *n* one-degree angles is said to have an angle measure of*n* degrees.

* + [CCSS.MATH.CONTENT.4.MD.C.6](http://www.corestandards.org/Math/Content/4/MD/C/6/)
	Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.
* Draw construct, and describe geometrical figures and describe the relationships between them.

* + [CCSS.MATH.CONTENT.7.G.A.1](http://www.corestandards.org/Math/Content/7/G/A/1/)
	Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

* + [CCSS.MATH.CONTENT.7.G.A.2](http://www.corestandards.org/Math/Content/7/G/A/2/)
	Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

Expert:

* Understand how different sundials work (including the importance of the latitude)
* Be able to build different sundials using trigonometry (e.g. equatorial sundials, one gnomon sundials, horizontal sundials, or multi-dials)
* Be able to calculate dial lines for a horizontal sundial:
	+ The sundial consists of the gnomon and the dial plate. For a horizontal sundial (like you find in your garden), the gnomon rises at an angle equal to the sundial site's latitude.
	+ But what about the hour lines on the dial plate? They must also match the sundial's latitude. Bannekar's sundial showed how to do this graphically. Here we'll use a simple formula and allow our screen calcuator to do the work (See column on the right)
	+ The formula for calculating the hour lines (theta) on a horizontal sundial is:
	+ **tan(theta) = tan(HA) x sin(lat)**
	+ where:
	+ **theta** = the resulting dial hour angle measured from the noon line (- is left of the noon line, + is right of the noon line)
	+ **HA**= the hour angle of the sun from the noon meridian, expressed in (+/-) degrees. The hours are minus in the morning (ante meridian) and positive in the afternoon (post meridian).
	+ **lat** = sundial site latitude, in degrees[[1]](#footnote-1)
* [CCSS.MATH.CONTENT.HSN.Q.A.2](http://www.corestandards.org/Math/Content/HSN/Q/A/2/)
Define appropriate quantities for the purpose of descriptive modeling.

* [CCSS.MATH.CONTENT.HSN.Q.A.3](http://www.corestandards.org/Math/Content/HSN/Q/A/3/)
Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

* [CCSS.MATH.CONTENT.HSA.SSE.A.1](http://www.corestandards.org/Math/Content/HSA/SSE/A/1/)
Interpret expressions that represent a quantity in terms of its context.

* [CCSS.MATH.CONTENT.HSG.SRT.D.11](http://www.corestandards.org/Math/Content/HSG/SRT/D/11/)
(+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Resources:

* North American Sundial Society: <http://sundials.org/>
* Building a Sundial: <http://ccphysics.us/henriques/a105l/Sundial.htm>
* The British Sundial Society: <http://sundialsoc.org.uk/>
	+ This one has great images and explanations of the gnomons position depending on where you are on earth under ‘Sundial Craft’ -> ‘How Sundials Work’
1. North American Sundial Society: http://sundials.org/index.php/teachers-corner/sundial-mathematics [↑](#footnote-ref-1)