Approximate Scale model of the Sun, Moon, and Earth to demonstrate an eclipse

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| Actual objects in our Solar System | Actual size in diameter | Actual distance from the Sun | Scale Model | Scale size | Scale distance |
| Sun | 1,392,000 km; 864,938 miles | 0 | Yoga Ball | 60-70 cm | 0 |
| Earth | 12,740 km; 7926 miles | 150 million KM; 93 million miles | Marble | 2cm | 65-70 meters; 70-75 yards |
| Moon | 3,474 km; 2,159 miles | 147 million km-152 million km; 91.3 million miles -94.4 million miles | Pea | 5mm | Roughly the same since the moon orbits the Earth it is sometimes closer & sometimes farther away |

# Essential question:

**How can something the size of the Moon completely cover up something the size of the Sun?**

**NGSS Standards:**

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| **1-ESS1-1.** | **Use observations of the sun, moon, and stars to describe patterns that can be predicted.** |

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| **5-ESS1-1.** | **Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from the Earth.** |
| **5-ESS1-2.** | **Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.** |

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| **MS-ESS1-1.** | **Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** |

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| **MS-ESS1-3.** | **Analyze and interpret data to determine scale properties of objects in the solar system.** |

**Common Core Math Standards:**

[CCSS.MATH.CONTENT.1.MD.A.1](http://www.corestandards.org/Math/Content/1/MD/A/1/)  
Order three objects by length; compare the lengths of two objects indirectly by using a third object.

[CCSS.MATH.CONTENT.1.MD.A.2](http://www.corestandards.org/Math/Content/1/MD/A/2/)  
Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. *Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps*.

[CCSS.MATH.CONTENT.2.MD.A.1](http://www.corestandards.org/Math/Content/2/MD/A/1/)  
Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

[CCSS.MATH.CONTENT.2.MD.A.2](http://www.corestandards.org/Math/Content/2/MD/A/2/)  
Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.

[CCSS.MATH.CONTENT.2.MD.A.3](http://www.corestandards.org/Math/Content/2/MD/A/3/)  
Estimate lengths using units of inches, feet, centimeters, and meters.

[CCSS.MATH.CONTENT.2.MD.A.4](http://www.corestandards.org/Math/Content/2/MD/A/4/)  
Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.

[CCSS.MATH.CONTENT.3.MD.B.3](http://www.corestandards.org/Math/Content/3/MD/B/3/)  
Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets*.

[CCSS.MATH.CONTENT.3.MD.B.4](http://www.corestandards.org/Math/Content/3/MD/B/4/)  
Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or quarters.

[CCSS.MATH.CONTENT.4.MD.A.1](http://www.corestandards.org/Math/Content/4/MD/A/1/)  
Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...*

[CCSS.MATH.CONTENT.5.MD.A.1](http://www.corestandards.org/Math/Content/5/MD/A/1/)  
Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

[CCSS.MATH.CONTENT.6.RP.A.1](http://www.corestandards.org/Math/Content/6/RP/A/1/)  
Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."*

[CCSS.MATH.CONTENT.6.RP.A.2](http://www.corestandards.org/Math/Content/6/RP/A/2/)  
Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."*1

[CCSS.MATH.CONTENT.6.RP.A.3](http://www.corestandards.org/Math/Content/6/RP/A/3/)  
Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

[CCSS.MATH.CONTENT.6.RP.A.3.A](http://www.corestandards.org/Math/Content/6/RP/A/3/a/)  
Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.

[CCSS.MATH.CONTENT.6.RP.A.3.B](http://www.corestandards.org/Math/Content/6/RP/A/3/b/)  
Solve unit rate problems including those involving unit pricing and constant speed. *For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?*

[CCSS.MATH.CONTENT.6.RP.A.3.C](http://www.corestandards.org/Math/Content/6/RP/A/3/c/)  
Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.

[CCSS.MATH.CONTENT.6.RP.A.3.D](http://www.corestandards.org/Math/Content/6/RP/A/3/d/)  
Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

**Materials:**

* Yoga Ball (60-70cm size) yellow or orange if possible
* Marble (3/4’ or close is the best size) blue if possible
* Green pea (frozen works best as they hold up to being handled)

**Procedures:**

*Teacher notes: This model is a relative, approximate scale model. It is difficult to get a marble that is exactly ¾” and peas can vary by a few mm.*

* Line all three objects next to each other
* Discuss scale model in an age appropriate manner
  + Why can’t we use the real Sun, Moon & Earth, etc.
* Discuss the real distances in an age appropriate manner
* Discuss scale model distances in an age appropriate manner
  + Things look bigger as they are closer to you, smaller as they are far away, etc.
  + Really cool web site for older students to play with scale distance & size of the whole solar system: <http://thinkzone.wlonk.com/SS/SolarSystemModel.php>
  + Another great website for distance and scale: <http://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html>
* Take the students out to a large playground that is at least 75 yards long
  + A football field is even better as it is easier to mark of the yardage
* Have a student or students take the Yoga ball to a distance of 65-75 yards away (This *distance is approximate depending mostly on the size of the yoga ball. It is a good idea to do this ahead of time to see where you need to be to cover up the yoga ball with the pea)*
* Students who are at the original distance, hold up the pea & see if they can make it cover up the Yoga ball. (It helps to close one eye and hold the pea up to the other eye. Students can adjust back and forth until it works)

**Additional activities:**

* Have the students draw what the sun looks like when they only cover part of the Sun with their moon as well as when they cover all of it.
  + Describe what it looks like & why it looks like that (a bite out of a cookie, smiley face, etc.)
* Discuss or have the students write about what ancient people would have thought of this
* There are many, many math activities that would also apply. See CC math standards above.