**Lesson Plan: Scaling the world’s largest telescope**

**Learning Overview:** The Giant Magellan Telescope could reveal signs of life on faraway planets — mainly because of the telescope’s massive mirrors. But just how big are they? Use this article to investigate the benefits of using scale and relative values in writing. Then solve a related word problem and devise your own useful examples of scale.

**NGSS-DCI:** HS-ESS1; MS-ESS1.

**Paired Article:**

*Science News:*“[How giant mirrors are made for what will be the world’s largest telescope](https://www.sciencenews.org/article/giant-mirrors-magellan-largest-telescope)”

Readability Score:12.6

**Directions**: Use the questions in the first section as a class discussion, then have students read the *Science News* article “[How giant mirrors are made for what will be the world’s largest telescope](https://www.sciencenews.org/article/giant-mirrors-magellan-largest-telescope)” and answer the remaining questions. You may choose to use questions in the third section as a group activity or an assessment.

**Defining scale**

1. Define scale and give an example. How can you use it to make sense of objects you haven’t seen?

*Scale is a mathematical relationship used to illustrate the size of objects by comparing them to something else. Scale is useful for objects or quantities that are very large or very small. For example, maps typically have a scale bar because they cover distances that are very large relative to the size of the paper they are drawn on. Scale is helpful to depict objects you haven’t seen, to provide a sense of their size compared with something you’re more familiar with. Students may mention that scales often refer to ratios between two quantities or give a measure of something as a proportion of something else.*

2. Choose two objects in your classroom and create a scale that relates them to each other.

*Student answers will vary. One example: the whiteboard is roughly the width of five chairs in a row.*

3. Come up with a scale for an object. Choose a celestial object, a part of the body that is invisible to the naked eye, an unfamiliar county’s size (or anything else that is unfamiliar to you) and compare it to a more familiar object.

*Student answers will vary.*

**The Magellan telescope and scale**

1. Write down some examples of scale that the article’s author used to explain the size of the Magellan telescope’s mirror.

*An enormous mirror — one as tall as a two-story house, if stood on edge*

*Together, the mirrors will function as a single unit, about as wide as an adult blue whale is long.*

*The mirror then undergoes two years of polishing, yielding a surface so smooth that if it were expanded to the size of North America, the tallest imperfection would be half as tall as a golf tee.*

2. How are literary devices used to describe the scale? Name at least one literary device used and highlight the sentence that uses it.

*Analogies and similes are used in the article to describe the scale. For example, a simile is used in the sentence “If all goes to plan, the molten material will anneal to form the body of an enormous mirror — one as tall as a two-story house, if stood on edge.”*

3. What is another way you could help a reader better understand the size of the mirror for the Magellan telescope? Come up with your own way of representing the scale of the mirror.

*Student answers will vary. Instead of describing the scale of the mirror in language, they could create a diagram that shows the scale. They could also think of another analogy that relates the size of the mirror to an object they’re familiar with.*

**Solving for scales**

1. The article states that the mirror has a “surface so smooth that if it were expanded to the size of North America, the tallest imperfection would be half as tall as a golf tee.” Given an average golf tee height of 3 inches (2.54 centimeters = 1 inch) and an area of North America of approximately 24.23 million square kilometers (km2), estimate the height of the tallest imperfection of the polished mirror at its current size. Give your answer in meters, then convert it to nanometers. Show your work.

*Half as tall as a golf tee would be 1.5 inches, or 0.038 meters. The diameter of the mirror is 8.5 meters wide. Using the diameter, you can calculate the area of the mirror using the following formula:*

*Area of mirror = π(D/2)2, which equals 56.7 m2*

*Area of North America (1 km2 = 1 x 106 m2) = 24.23 x 106 km2 = 24.23 x 1012 m2*

*Create a proportion of the areas to the golf tee length and solve for the unknown length. The imperfection would be about 8.90 x 10-14 m, or 8.90 x 10-5 nm.*

2. Why do you think the author of the article explained the size of the imperfection using an analogy instead of stating the exact size? Explain.

*The comparison helps me understand how tiny the imperfections are. I can grasp the size of a golf tee. The half-golf tee-sized imperfection is very small compared with the size of North America Similarly, the actual size of the imperfection must be tiny compared with the size of the mirror. The size of the imperfection that I found in my calculation was so small that it was difficult to understand. That’s probably why the author used the comparison instead of the absolute value.*

3. Read through the article again and write down all examples of scales not related to the size of the Magellan telescope that you can find (there are many!).

*Student answers will vary. They may mention the furnace’s description in the first paragraph — carousel-sized, fire truck red, shaped like a flying saucer. The amount of borosilicate glass is nearly 17,500 kilograms, roughly four semitruck loads. The new telescope’s resolution is 4 times better than today’s most advanced telescopes. The mirror size of the new telescope is compared to the James Webb Space Telescope mirror size.*

4. What’s another quantity or value given in the article that is difficult to grasp in terms of its magnitude? Devise your own way of helping a reader understand the quantity or value given by writing a literary device that scales the amount or size to something more familiar or by providing a diagram.

*The article states that the furnace’s temperature reaches 1,165 degrees Celsius and states that a 100-nanometer thick coat of aluminum is applied to the clear glass surface. It would be helpful to use a comparison to better understand both quantities. For example, 100 nanometers is a thousand times smaller than the thickness of a typical sheet of paper.*