Name: _____ Date: _____

Two Shadows Helped Measure the Whole Earth

Circle group

More than two thousand years ago, a Greek scholar named Eratosthenes worked in a great library in Alexandria, in Egypt. He heard about a deep well in a southern town called Syene. On one day each summer, at noon, the sun shone straight down the well. It lit the water at the bottom. That meant the sun was right overhead in Syene.

Eratosthenes wondered about the same day in Alexandria. He set up a tall pole. He watched its shadow at noon. The pole did cast a shadow. So the sun was not straight overhead there. He measured how far the sun's rays tilted from the pole. It was about one fiftieth of a full circle.

Here is the clever part. Sunlight reaches Earth in nearly parallel rays. If the ground were flat, both towns would have the same shadows. They did not. So the ground must curve between them. The angle of the shadow matched the curve of Earth between the two places.

Eratosthenes knew about how far apart the towns were. Surveyors had paced it off. That distance was one fiftieth of the way around Earth. So the whole trip had to be fifty times longer. He multiplied. He got a number for the size of the planet.

His answer was close to what we know today. He only used a pole, the sun and good thinking.

Questions

1. What happened in the well at Syene at noon on one summer day?

_____

_____

2. What did the pole in Alexandria show?

_____

_____

3. What part of a full circle was the angle of the shadow?

_____

_____

4. Why did different shadows in the two towns suggest that Earth is curved?

_____

_____

5. How did Eratosthenes use the distance between the towns to get the size of Earth?

_____

_____

6. What did Eratosthenes use?

_____

_____

Words to know

scholar: a person who studies and knows a lot
overhead: directly above you
parallel: lines going the same way that never meet
surveyors: people who measure land and distances

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

Name: _____ Date: _____

Two Shadows Helped Measure the Whole Earth

Triangle group

More than two thousand years ago, a Greek scholar named Eratosthenes worked in the great library in Alexandria, in Egypt. He heard about a deep well in a southern town called Syene. On one day each summer, at noon, sunlight shone straight down the well and lit the water at the bottom. This meant that the sun was directly overhead in Syene at that moment.

Eratosthenes wondered about the same day in Alexandria. He set up a tall pole and watched its shadow at noon. The pole did cast a shadow, which meant the sun was not straight overhead there. He measured how far the sun's rays tilted from the pole, and it was about one fiftieth of a full circle.

Here is the clever part. Sunlight reaches Earth in nearly parallel rays. If the ground were flat, the two towns would have the same shadows. Different shadows meant the surface curved between them. The angle of the shadow matched the curve of Earth between the two places.

Eratosthenes knew roughly how far apart the towns were, because surveyors had paced it off. If that distance was one fiftieth of the way around Earth, then the whole trip had to be fifty times longer. He multiplied, and he got a number for the size of the planet.

His answer was surprisingly close to what we know today. He used only a pole, the sun and good thinking.

Questions

1. What happened in the well at Syene at noon on one summer day?

_____

_____

2. What did the pole in Alexandria show?

_____

_____

3. What fraction of a full circle was the angle of the shadow?

_____

_____

4. Why did different shadows in the two towns suggest that Earth is curved?

_____

_____

5. How did Eratosthenes get the size of the whole Earth from the distance between the towns?

_____

_____

6. What tools did Eratosthenes use?

_____

_____

Words to know

scholar: a person who studies and knows a lot
overhead: directly above you
parallel: lines going the same way that never meet
surveyors: people who measure land and distances
curved: bent in a smooth round shape

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

Name: _____ Date: _____

Two Shadows Helped Measure the Whole Earth

Square group

More than two thousand years ago, a Greek scholar named Eratosthenes worked in the renowned library at Alexandria, in Egypt. He learned of a deep well in a southern town called Syene. On one particular day each summer, at noon, sunlight shone straight down the well and illuminated the water at the bottom. This indicated that the sun was directly overhead in Syene at that moment.

Eratosthenes became curious about the same day in Alexandria. He erected a tall pole and observed its shadow at noon. The pole did cast a shadow, which meant the sun was not straight overhead there. He measured how far the sun's rays were slanted away from the pole, and the angle turned out to be about one fiftieth of a full circle.

Here is the clever part. Sunlight reaches Earth in nearly parallel rays. If the ground were flat, the two towns would have identical shadows. Because the shadows differed, the surface had to curve between them, and the angle of the shadow matched the curve of Earth between the two places.

Eratosthenes knew approximately how far apart the towns were, since surveyors had paced off the distance. If that distance represented one fiftieth of the way around Earth, then the complete journey had to be fifty times longer. He multiplied, and he arrived at a figure for the size of the entire planet.

His answer was surprisingly close to what we know today, and he reached it using nothing more than a pole, the sun and careful thinking.

Questions

1. What happened in the well at Syene at noon on one summer day?

_____

_____

2. What did the pole in Alexandria reveal?

_____

_____

3. What fraction of a full circle was the angle of the shadow?

_____

_____

4. Why did the differing shadows in the two towns suggest that Earth is curved?

_____

_____

5. How did Eratosthenes turn the distance between the towns into the size of the whole Earth?

_____

_____

6. What did Eratosthenes use to reach his answer?

_____

_____

Words to know

scholar: a person who studies and knows a lot
overhead: directly above you
parallel: lines going the same way that never meet
surveyors: people who measure land and distances

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

For the teacher: Two Shadows Helped Measure the Whole Earth

Each student sheet carries a shape, not a level. The same topic and facts, written three ways.

Circle: Two Shadows Helped Measure the Whole Earth

Easier · 229 words · Flesch-Kincaid grade 3.5

1. The sun shone straight down and lit the water at the bottom.
2. It cast a shadow, so the sun was not straight overhead there.
3. About one fiftieth.
4. On flat ground the shadows would match, so the ground must curve between them.
5. He multiplied it by fifty.
6. A pole, the sun and good thinking.

Triangle: Two Shadows Helped Measure the Whole Earth

This passage · 237 words · Flesch-Kincaid grade 5.7

1. Sunlight shone straight down and lit the water at the bottom.
2. It cast a shadow, so the sun was not straight overhead there.
3. About one fiftieth.
4. On flat ground the shadows would match, so the surface must curve between the places.
5. He multiplied that distance by fifty.
6. A pole, the sun and good thinking.

Square: Two Shadows Helped Measure the Whole Earth

Harder · 255 words · Flesch-Kincaid grade 7.9

1. Sunlight shone straight down and illuminated the water at the bottom.
2. It cast a shadow, so the sun was not straight overhead there.
3. About one fiftieth.
4. On flat ground the shadows would be identical, so the surface must curve between the places.
5. He multiplied that distance by fifty.
6. A pole, the sun and careful thinking.