# Math Meets Nature

Compare two ancient approaches to scientific problems.

**AWH.C.6.4.D** "Science and Engineering: Archimedes, Ptolemy"

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline a mathematical idea used by each thinker, circle what each idea helped people do, and write 1 and 2 beside passages that show how their ideas could be checked.

### Archimedes and Ptolemy

1. Imagine a dock in Syracuse in the third century BCE, with a heavy load that workers need to move. Archimedes, a Greek mathematician and engineer who lived in Syracuse, studied how forces work. He showed that a lever can move a heavy object when a smaller force acts farther from the pivot. He also explained buoyancy: water pushes upward on an object with a force equal to the weight of the water the object displaces. These ideas connected mathematical reasoning to physical effects that workers could observe, measure, and use.

2. Centuries later, in second-century CE Alexandria, Ptolemy worked on a different problem: predicting the positions of objects in the sky. He gathered earlier observations and used geometric models and calculations in the *Almagest*. In his model, Earth stood still at the center while the sun, moon, and planets moved around it in complex paths. His tables helped readers estimate where planets would appear on particular dates. A prediction could be checked against a later sighting. Yet an accurate prediction alone did not prove that the model's picture of the universe was correct.

3. Both thinkers used mathematics to find patterns, but their work did not answer the same kind of question. Archimedes studied forces that could be tested with objects and water. Ptolemy built a system for calculating future positions from recorded sightings. His Earth-centered picture remained influential for many centuries, even though later evidence supported a sun-centered solar system. This difference matters: a model can be useful for a task while still giving a mistaken explanation of how nature works. To judge an ancient scientific idea, ask what it explained, how people tested it, and where it fell short.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. How did Archimedes connect a mathematical idea to the problem of moving a heavy object?

2. How did Ptolemy use observations and geometry to make a prediction people could check?

3. What different kinds of results could people check in Archimedes' and Ptolemy's work?

4. Why did Ptolemy's useful predictions not prove that his Earth-centered model was correct?

## 3 YOUR TURN

Your own words

Write an 80 to 100 word museum label comparing how Archimedes and Ptolemy used mathematics. Give one new use for each thinker's approach that is not described in the passage, and explain why Ptolemy's useful predictions did not prove his model was correct.

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## PART 1 · READ AND MARK

Underline a mathematical idea used by each thinker, circle what each idea helped people do, and write 1 and 2 beside passages that show how their ideas could be checked. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | How did Archimedes connect a mathematical idea to the problem of moving a heavy object? | **He showed that a smaller force applied farther from a lever's pivot can move a heavy object.** |
| 2 | How did Ptolemy use observations and geometry to make a prediction people could check? | **He used earlier sky observations and geometric calculations to estimate where planets would appear on particular dates. People could check the estimates against later sightings.** |
| 3 | What different kinds of results could people check in Archimedes' and Ptolemy's work? | **People could observe and measure the effects of forces in Archimedes' work. They could compare Ptolemy's predicted planet positions with later sightings.** |
| 4 | Why did Ptolemy's useful predictions not prove that his Earth-centered model was correct? | **A model can predict positions while giving a mistaken explanation. Later evidence supported a sun-centered solar system.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

Archimedes and Ptolemy both used mathematics to make nature more understandable, but they studied different problems. Archimedes analyzed forces; his rule for buoyancy could help a builder decide whether a new ferry can carry a load without sinking. Ptolemy combined past sky sightings with geometry; an observer could use his tables to plan a public viewing of Jupiter. Each approach gave people a way to act on a calculation. Ptolemy's predictions could work even though his Earth-centered explanation was mistaken. A useful prediction is not always a correct picture of the universe.

Accept other plausible new uses that apply Archimedes' work on forces or buoyancy and Ptolemy's approach to predicting sky positions. The label should distinguish useful predictions from a correct explanation.