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Phases of the Moon:
A Squared Away Unit

From 'Phases of the Moon: A Squared Away Unit'. Product code INT853.
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Learn Through Experience

About the author

Fran Lyons Sammons completed her undergraduate and graduate work at the University of Rhode Island. After 30 years as a classroom teacher in Jamestown, RI, she is now a freelance writer and consultant to school districts helping them implement standards-based curricula. She has written, co-authored, and contributed to several Interact titles, including *Election*, *House Design*, *Personal Finance*, and *Branches of Government*. When she's not busy promoting active learning, she can be found sailing with her husband Jim, who is a science writer and retired science teacher.

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Duplication

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Phases of the Moon

A Squared Away Unit

Purpose

Although all students are aware that the Moon changes its appearance over the course of a month, many may not know what causes the Moon to change. This is not surprising. When asked, an alarming number of Harvard graduates could not explain what causes the phases of the Moon. However, in the next few days your students will create models of the phases of the Moon and of solar and lunar eclipses. By the end of this unit they will have discovered what truly causes the phases of the Moon and how eclipses occur.

Educational standards

National Science Education Standards

- As a result of their activities in grades 5–8, all students can develop descriptions, explanations, predictions, and models using evidence, and can communicate scientific procedures and explanations.
- As a result of their activities in grades 5–8, all students should develop an understanding of the Earth in the solar system, realizing that most objects in the solar system are in regular and predictable motion, and that those motions explain such phenomena as the day, the year, phases of the Moon, and eclipses.

National Center on Education and the Economy New Standards Performance Standards, 1997

Earth and Space Science Concepts

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions, and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard. In particular, the student demonstrates understanding of the Earth in the solar system, including such phenomena as the predictable motions of planets, moons, and other objects; how those motions cause days, years, moon phases, and eclipses; and the Sun's role as the major source of energy for phenomena on the Earth's surface.

Scientific Thinking

The student uses scientific concepts to explain a variety of observations and phenomena, and uses evidence from reliable sources to develop descriptions, explanations, and models.

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National Council of Teachers of Mathematics Principles and Standards for School Mathematics

Number and Operations Standard for Grades 6–8

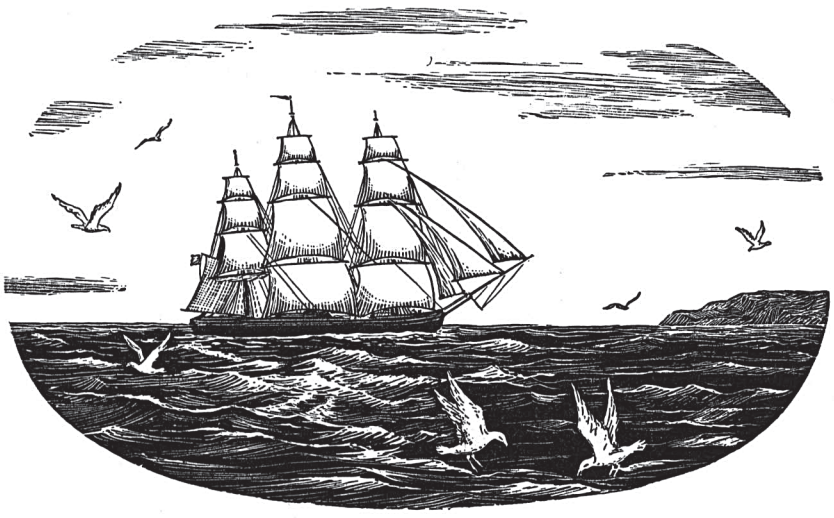
All students should understand and use ratios and proportions to represent quantitative relationships.

Representation

All students should use representations to model and interpret physical, social, and mathematical phenomena.

Connections

All students should recognize and apply mathematics in contexts outside of mathematics.



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Lesson Plan

Introducing Earth, Moon, and Sun

1. Essay 1A: Ancient Astronomers

- Give Managers copies of **Essay 1A: Ancient Astronomers** for each of their team members. Go over the essay as a whole-class activity.
- Make sure that students understand any new vocabulary introduced in the essay: *BCE*, *CE*, *archaeologists*, *astronomers*, *solar*, *lunar*, *heliocentric*, and *geocentric*.

2. Stop/Think/Draw/Write 1

- After completing the discussion of **Essay 1A**, give team Managers copies of **Stop/Think/Draw/Write 1** to distribute to their teammates. Have students fill in their names and the date. Then ask students explain the difference between *geocentric* and *heliocentric* in the space provided. Allow teams 3–5 minutes to complete their work.
- Within their teams, have students share what they wrote or drew. Then ask each team to choose one teammate's explanations and drawings to share with the whole class.
- Using the **Content Concept Rubric**, have the whole class assess team answers. Reinforce correct explanations and clear up any confusing or inaccurate answers. Summarize the explanations and model the correct drawings on the chalkboard.
- Send students back to their teams to correct all their papers, if necessary.

3. Essay 1B: Measuring the Sun, Earth, and Moon

- Give copies of **Essay 1B: Measuring the Sun, Earth, and Moon** to each team Manager to distribute to their team members. Go over the essay as a whole-class activity or as a team activity. Review roles if assigning a team activity.
- Make certain students understand any new vocabulary introduced in the essay: *diameter*, *kilometers* and *miles* (1 km equals 0.6 mile), *elliptical orbit*, *average*.
- Decide whether you are using kilometers or miles (see the Teaching Tip to the right).

Small group

Teaching tip
Remind students that when asked to draw, they should work quickly using simple sketches. Labels should be clear and spelled correctly.

Whole class

Whole class

or

Small group

Teaching tip
Note that the distances are given in kilometers and miles. Using miles is easier when the students do the math, because the essay gives the distance to the Moon as about a quarter million miles. The Sun then is $4 \times 93 = 372$ (or almost 400) times farther away than the Moon. The Sun is also about 400 times larger than the Moon.

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4. "You Do the Math" for Scale


Whole class

- Give Managers copies of the worksheet "**You Do the Math" for Scale**, one for each of their teammates. Go over the handout as a whole-class activity. This may take more time if students are not familiar with scale.
- Show students how to cancel zeros when doing division of large numbers. Allow students to use calculators, if necessary.

For example: 3000/150,000
= ~~3000~~/150,~~000~~
= 3/150
*= **50***

5. Making scale models


Small group

Bright Idea
Review roles when assigning a team activity.

- Give Team Managers one copy of Making Scale Models for their team. Tell team Managers to collect materials for their team in order to complete the **Making Scale Models** activity.
- Allow teams five minutes to complete **Part One**. When teams have finished, have teams check each other's measurements. Reinforce correct measurements and clear up any mistakes. Remind them that scale allows them to make valid comparisons.

Teaching tip
Use the **Concept Content Rubrics** or **Cooperative Group Work Rubrics** to award points to teams. Keeping track of points sometimes motivates teams to make stronger efforts.

- Direct students to **Part Two**. Allow students to work independently for 3–5 minutes. When they finish they should send the Leader to you with their length of string showing the scaled distance between the Earth and the Moon. (The string piece will be less than one centimeter.)

6. Stop/Think/Draw/Write 1


Individual

- When teams have finished with the activity, students should work individually to answer the prompts on the bottom of the handout. While they work, walk around and check that students who have finished early have included all they know. Remind students to work neatly and check their spelling.


Small group

- Allow teams 3–4 minutes to complete their work. Have students first share what they wrote or drew with their team. Then ask each team to choose one teammate's explanations and drawings to share with the whole class.
- Use the **Concept Content Rubric** to assess team answers. Reinforce correct explanations and clear up those that are confusing or inaccurate. Summarize the explanations and model the correct drawings on the chalkboard. Ask students to correct their papers if their explanations were incorrect or confusing.

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Name: _____ Date: _____

"You Do the Math"

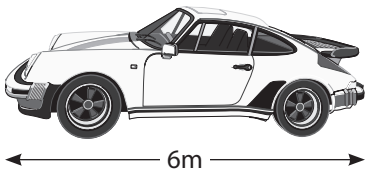
Worksheet for Scale Models

It is not enough just to read a number, especially a large number, and assume you understand what it represents. This is especially true when measuring objects in space. The Moon looks bigger than the Sun, but the Moon is much closer to the Earth than the Sun is. Just how far away is the Moon? How much farther away is the Sun? How does the Moon compare in size to the Earth? To the Sun? Only by making scale models of the Earth, Moon, and Sun can you fully compare and appreciate both the size and distance differences among these three objects in space.

In order to create scale models, you need to get the measurement of an actual object and establish the scale.

How to determine the scale model size

Example 1: The easiest scales are one-to-one scales such as "one meter equals one centimeter." In this scale, if a car were six meters long, then the scale drawing of the car would be six centimeters long.



Example 2: You have worked often with scale when doing map work. In maps, an example of a common scale might be "one centimeter equals one hundred miles." With this scale, you could draw a map of a continent that is 2500 miles long and 1500 miles wide on a sheet of loose-leaf paper, and the scale drawing would only be 25 cm by 15 cm.

Think about this: If the scale were "200 km = 1 cm," how long would your drawing of a 600 km road be? (Hint: How many 200 km sections are in a 600 km road?)

Practice

1. If a satellite were orbiting 10,000 km above the Earth, how far would that be on a scale drawing with the scale of "2000 km = 1 cm"?
2. If the scale were "10,000 km = 1 cm," how long a line would you draw to show the 6000 km distance between Chicago and London? (Hint: The answer can be less than one centimeter.)

This chart shows some big numbers associated with the Earth, Moon, and Sun.

	Moon	Earth	Sun
Average distance from Earth	384,400 km 230,640 miles		149,000,000 km 93,000,000 miles
Actual diameter	3500 km 2200 miles	12,800 km 8000 miles	1,400,000 km 840,000 miles

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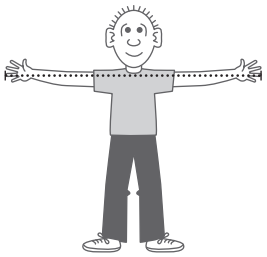
Name: _____ Date: _____

Making Scale Models



100 cm = about one arm

Materials for your team

- meter stick
- centimeter ruler
- calculators
- ribbon or string three meters long
- centimeter paper
- scissors

Math Shortcut:

$$\frac{150{,}000}{3000} = \frac{150}{3} = 50$$

Part One

The average distance from the Earth to the Sun equals 93,000,000 miles, or 149,000,000 kilometers.

Do the math to scale the distance from the Earth to the Sun.

Use the scale of 1,000,000 miles (or km) = 1 cm.

$$\frac{\text{_____}}{1{,}000{,}000} = \text{_____ cm}$$

Using the answer you calculated in the block above, cut a piece of string or ribbon to scale to show the average scaled distance between the Earth and Sun.

Part Two

The average distance from the Earth to the Moon equals 230,640 miles, or 384,400 kilometers.

Do the math to scale the distance from the Earth to the Moon.

Use the scale of 1,000,000 miles (or km) = 1 cm.

$$\frac{\text{_____}}{1{,}000{,}000} = \text{_____ cm}$$

Using the answer you calculated in the block above, cut a piece of string or ribbon to scale to show the average scaled distance between the Earth and the Moon.

Compare the two lengths of string.

CHALLENGE: How many times farther away from the Earth is the Sun, than the Moon? _____

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