Solar System Scale & Size

Grades: K-4 Prep Time: ~20 Minutes Lesson Time: ~60 minutes



WHAT STUDENTS DO: Explore Size and Distance Relationships among Planets

Students will create a model of the solar system using beads and string, and compare planetary sizes using common types of fruit and seeds. In this collection, this lesson follows the simple balloon model in Lesson 2, covering the relationships of size and distance in the solar system. It reinforces concepts students have just encountered in terms of scale and distance and the way in which models assist us in understanding.

NRC CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES
WHAT IS THE UNIVERSE & WHAT IS EARTH'S PLACE IN IT? *NRC Core Question: ESS1: Earth's Place in the Universe*	*Students will be able*
What are the predictable patterns caused by Earth's movement in the solar system? *NRC ESS1.B: Earth and the Solar System*	**IO1: to model** the relative size and distance of the solar system

See Section 4.0 and Teacher Guide at the end of this lesson for details on Instructional Objective(s), Learning Outcomes, Standards, & and Rubrics.

1.0 Materials

Required Materials

Please supply:

For Solar System Bead Model

- Large craft pony beads in 11 suggested colors (1 of each listed below) per student
  - Yellow (Sun)
  - Opaque Red (Mercury)
  - Cream (Venus)
  - Clear Blue (Earth)
  - Clear Red (Mars)
  - Black (Asteroid belt)
  - Orange (Jupiter)
  - Clear Gold (Saturn)
  - Dark Blue (Uranus)
  - Light Blue (Neptune)
  - Brown (Pluto - dwarf planet)
- 4.5 meters of string for each student
- Small piece of cardboard to wrap the Solar System string around (10 cm X 10 cm) after the project is complete
- Measuring tapes (with centimeters), meter sticks, or other metric measuring tools

Teacher Tip: Buying the String: To prevent tangling frustrations, a specific type of string is strongly suggested. You will be looking for string that is thicker than twine, but thinner than yarn. It is 100% cotton, 4-ply knitting and weaving yarn that many times can be bought on a large cone.

Differentiation Tip: Solar System Beads For younger students or to speed up the activity:

1. The string may be pre-cut and a set of Solar System beads may be put into a plastic baggie for each student.
2. A pre-measured marking grid can be put on a table top so the students can mark their measured distances, then tie off the beads.
3. If students will be marking their string ahead of time for each planet, tape newspaper to the floor to prevent marking the floor. 4 cm will need to be added to each planet distance measurement to accommodate tying of the bead (double knot).

For "Farmer's Market Solar System (Class Demo)

- 1 Honeydew Melon
- 1 Cantaloupe
- 1 Lemon
- 1 Lime
- 2 Grapes
- 1 Macadamia Nut
- 3 Peppercorns

Please Print:

From Student Guide:

(A)	Solar System Predictions	– 1 per student
(B)	Solar System Beads	– 1 per student
(C)	Planet Bead Calculations	– 1 per student
(D)	Farmer's Market Solar System	– 1 per student

Optional Materials

From Teacher Guide:

(E) Farmer's Market Solar System Key
(F) Solar System Cut-outs
(G) "Solar System Size and Scale" Assessment Rubrics
(H) Alignment of Instructional Objective(s) and Learning Outcome(s) with Knowledge and Cognitive Process Types

2.0 Vocabulary

Astronomical Unit (AU)	a standard measurement used within the solar system; Earth is 1 AU from the Sun
Models	a simulation that helps explain natural and human-made systems and shows possible flaws
Planet	a sphere moving in orbit around a star (e.g., Earth moving around the sun)
Prediction	the use of knowledge to identify and explain observations or changes in advance (NSES, 1996)
Relationship	the connection among and between objects
Scale	a measurement that will represent a standard measurement for comparison among objects
Solar System	our solar system has 8 planets moving in orbit around the sun, along with dwarf planets such as Pluto, comets, asteroids, and moons; some other stars, like the Sun, have solar systems (planets and other bodies orbiting them) too
System	an organized group of related objects or components that form a whole (NSES, 1996)

3.0 Procedures

PREPARATION (~45 minutes)

Constructing the "Solar System Beads"

A. For each student, have available: string cut in 4.5 m lengths, colored beads, cardboard, tape, and measuring tools.

Printing:

B. Handouts (A) – (D) in the Student Guide at the end of this lesson.

Preparing the "Farmer's Market Solar System"

C. Have fruits on hand for students to examine, or provide cutouts found in *(F) Farmer's Market Solar System, Low-cost Cutouts*

STEP 1: ENGAGE (~10 minutes)

Making Predictions

A. Ask students to imagine taking a vacation, visiting all of the planets and other cool destinations in the solar system. When we plan a vacation or trip here on Earth, we have to think about how far away things are, and how long it will take us to get to each place. Ask students to start with their predictions of how long it would take to reach each planet or other body from Earth by drawing relative distances. They should use *(A) Solar System Predictions* in the Student Guide at the end of this lesson. Their predictions are represented by a drawing of what students believe the distance to be between the planets (to the scale of a regular size piece of paper). Ask them to draw all of the planets, including the Sun and Asteroid Belt, showing what they believe to be the relative distances between these bodies. Students may need a reminder about all of the planets and their order in the Solar System.

Ask students to make a second prediction, this time with additional information. Explain to them that if we were to drive a car at highway speeds to the Sun, it would take about 163 years to get there. If we were to travel at the same speed to Mars, it would take 81 years. To get to dwarf planet Pluto, it would take 6,357 years! Obviously, we travel faster than a car when we use a rocket to blast off (e.g., to Mars, spacecraft travel at ~12,000 miles per hour), but the highway comparison gives students an idea of relative distance.

Differentiation Tip: For older or more advanced students, have students calculate mathematically.

STEP 2: EXPLORE (~10 minutes)

Finding the Scale

A. Hand out *(B) Solar System Beads Instruction She*et and (*C) Planet Beads Calculation Worksheet*.

B. Have older students complete the table in *(C) Planet Beads Calculation Worksheet*, converting the various AU distances to centimeters, and complete the chart provided. For very young students (K-1), complete this project together using non-standard measurements to represent each AU.

C. Have students measure and cut a piece of string 4.5 meters long.

D. Using the calculated cm distances, tie the bead onto the string using a double knot.

E. When students finish the activity, review the models, then wrap the Solar System string (with beads) around the cardboard holder.

Differentiation Tip: **Solar System Beads** for older or more advanced students, measurements can be made each time from the Sun to the planet and tied on after each measurement. Thus, no additional 4 cm length will be needed in completing the model in this way.

STEP 3: EXPLAIN (~20 minutes)

Explaining the relationship between their predictions and results.

A. Have older students complete the questions on *(C) Planet Beads Calculation Worksheet.* Discuss with younger students.

STEP 4: ELABORATE (~10 minutes)

A. For this step, allow students to examine the fruits, nuts, and peppercorns (or cut-out shapes in the Teacher Guide). Explain to students, now that they have an idea of the scale and distance between planets, that it will also apply to the size of the planets. Ask them to predict the size of each planet in the solar system using these materials and the *(D) Farmer's Market Solar System Worksheet*. They may use some fruits, nuts, and peppercorns more than once. Ask them to work collaboratively to discuss potential sizes.

B. Once students are finished, using *(E) Farmer's Market Solar System Key*, reveal the Farmer's Market Solar System for students to compare their results.

STEP 5: EVALUATE (~20 minutes)

Assessing Proposed Strengths and Weaknesses of Missions.

A. By completing the final two questions on *(D) Farmer's Market Solar System Worksheet*, students will reflect on what they have learned. In a group discussion, ask them to compare their initial predictions with what they now know. This conversation is a good time to reinforce the idea that science is all about not knowing at first, but finding ways (e.g., using models, making predictions) to gain new knowledge. It is also a good time to reinforce that they are capable of being scientists by following their curiosity, making predictions, collecting data, and revising their original ideas with new information.

4.0 Extensions

Students may be curious about why Pluto is no longer considered a planet, and our solar system now has 8 planets instead of 9 as we once thought. Have a discussion about classification—looking at common characteristics to group like things. Explain how, before we began exploring the solar system with spacecraft and before we had more powerful telescopes and other tools, we didn't realize that Pluto was a lot more like other bodies, called dwarf planets, than it is like the 8 planets in our solar system. It's a good opportunity to discuss that science is about continuously revising our models as we discover new things.

5.0 Evaluation/Assessment

In the Teacher Guide, use the *(G) "Solar System" Rubric* as a formative assessment that aligns with the Common Core, Next Generation Science Standards, National Science Education Standards, and the instructional objective(s) and learning outcomes in this lesson.

(A) Student Handout. Solar System Predictions

NAME:________________________________

1. Draw your predictions of the Solar System. Your teacher will give you directions.

Prediction 1:	**Prediction 2:**

(B) Student Instruction Sheet. Solar System Beads

Introduction:

We think about planets *revolving around* the Sun, but do not think about *how far* each planet *is* from the Sun. Astronomers use the distance from the Sun to the Earth as an "Astronomical Unit," or AU. This unit gives us an easy way to calculate the distances of the other planets from the Sun.

Astronomical Unit: 1 AU = ~150 million kilometers (93 million miles)

Directions:

You will construct a distance model of the Solar System to scale, using colored beads as planets. The chart on the next page shows the planets and asteroid belt in order along with their distance from the Sun in astronomical units.

For this activity 1 AU = 10 cm

1. Complete the chart by multiplying each AU distance by our scale factor of 10 cm per AU. This procedure will give you the measurement of each planet in cm for your model.
2. Use the new distance (in cm) to construct a scale model of our Solar System.
3. Start your model by cutting a 4.5 m piece of string.
4. Use the distances that you have calculated in the chart below to measure the distance from the Sun on the string to the appropriate planet and tie the colored bead in place
5. When you are finished, complete the "Planet Bead Calculation Sheet" and show your model to your teacher.

Note:

If you were traveling at the speed of light (~300,000 kilometers per second), it would take 8 minutes to travel from the Sun (Earth's nearest star) to the Earth (1 AU). It would take 4.3 years at the same speed to reach the next nearest star to Earth, Alpha Centauri.

(C) Student Worksheet. Planet Bead Calculation Sheet

Planet	AU	Scale Value (cm)	Color
Sun	**0.0**		
Mercury	**0.4**		
Venus	**0.7**		
Earth	**1.0**		
Mars	**1.5**		
Asteroid Belt	**2.8**		
Jupiter	**5.0**		
Saturn	**10.0**		
Uranus	**19.0**		
Neptune	**30.0**		
Pluto (Dwarf Planet)	**39.0**		

Compare your bead model to the predictions you made in *(A) Solar System Predictions*.

1. **How close was your prediction to the actual model? What are the differences and similarities between the model and your predictions?**

2. **When you go home and show your family or friends your bead model, what will you tell them was the most surprising thing you learned about the solar system?**

(D) Student Worksheet. Farmer's Market Solar System

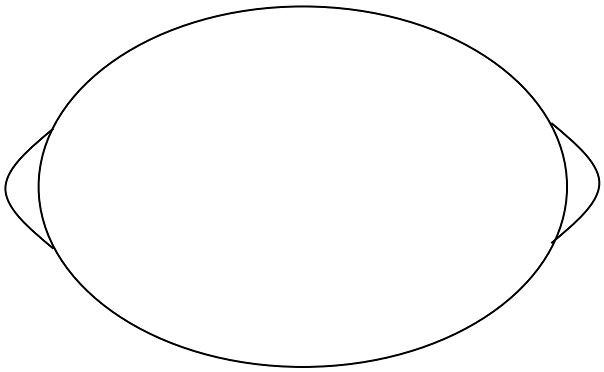
Working with your partner or group, discuss the fruits and vegetables your teacher has provided. For each body in the solar system, select one of these as a representation of their size in relationship to each other. In the justification column, explain why you believe this particular fruit or vegetable to be the best choice.

Planet	Object	Justification
Mercury		
Venus		
Earth		
Moon		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		
(Pluto)		

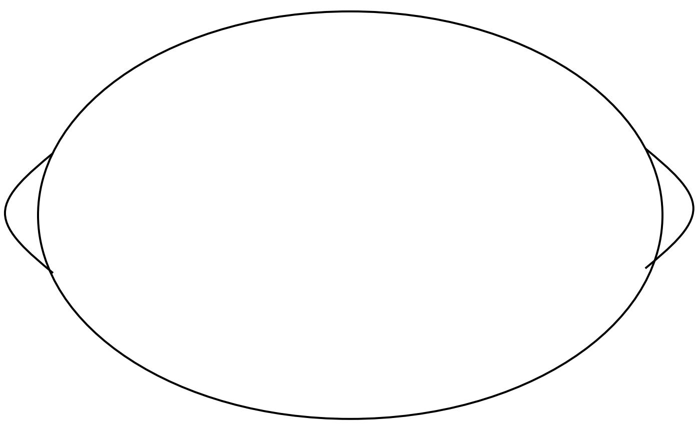
(E) Teacher Resource. Farmer's Solar System Key

Planet	Object	Justification
Mercury	*Peppercorn*	
Venus	*Grape*	
Earth	*Grape*	
Moon	*Peppercorn*	
Mars	*Macadamia Nut*	
Jupiter	*Honeydew*	
Saturn	*Cantaloupe*	
Uranus	*Lemon*	
Neptune	*Lime*	
(Pluto)	*Peppercorn*	

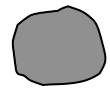
(F) Teacher Resource. Farmer’s Market Solar System, Low-cost Cutouts (1 of 3)



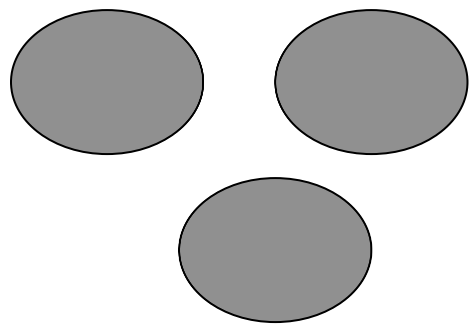
Lime



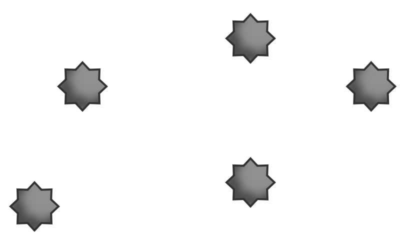
Lemon



Macadamia Nut

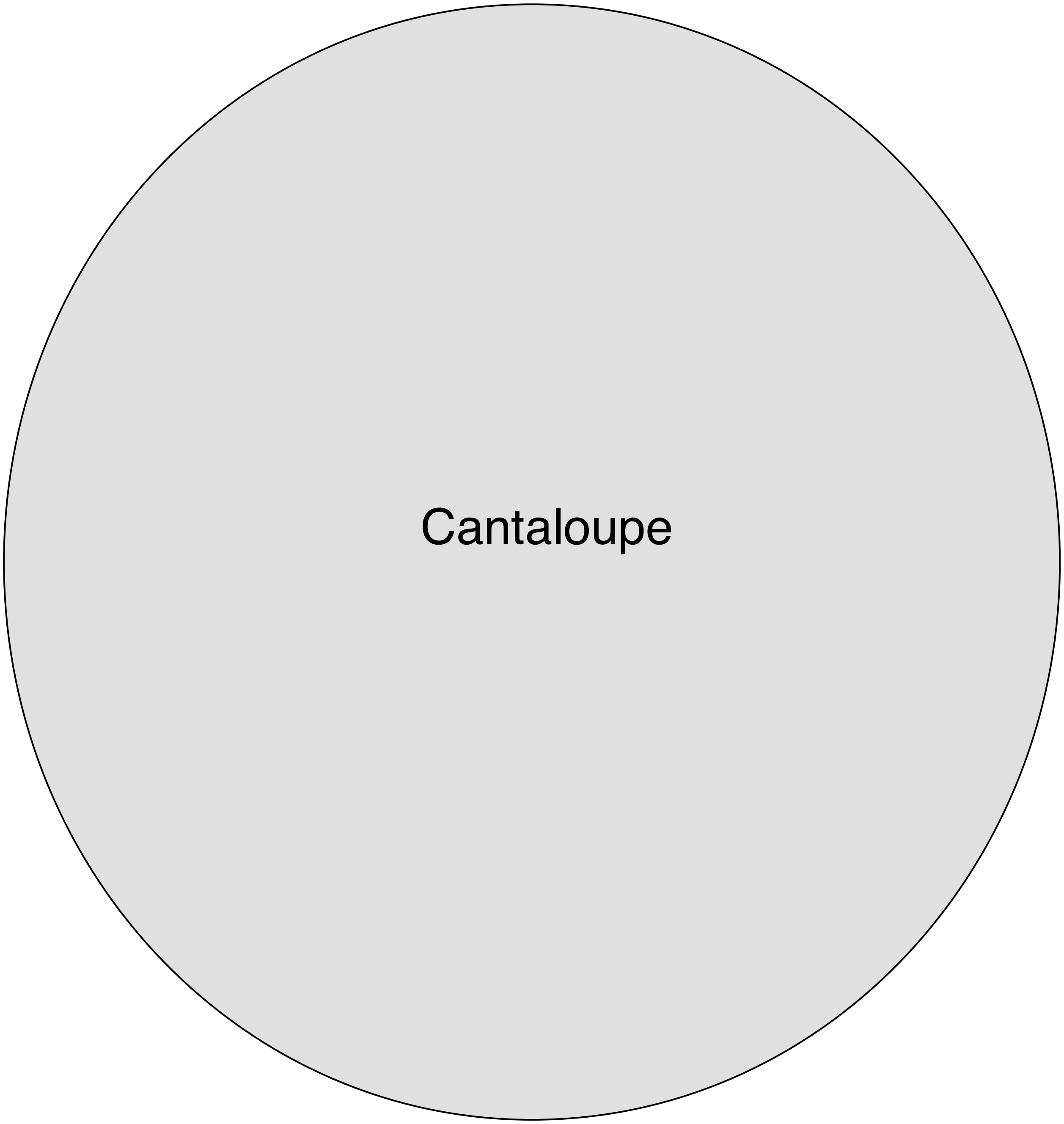


Grapes



Peppercorns

(F) Teacher Resource. Farmer's Market Solar System, Low-cost Cutouts (2 of 3)



(F) Teacher Resource. Farmer's Market Solar System, Low-cost Cutouts (3 of 3)