Mars Habitation

Solar System Scale and Size

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.

Supporting Video: https://mars.nasa.gov/msl/multimedia/videos/index.cfm?v=38

Materials were edited for the purpose and benefit of the University of Houston's Mars Rover Celebration.

Overview

In this lesson plan students will:

- Create a model of the solar system using beads and string
- Compare planetary sizes using common types of fruit and seeds

Process/Skills

Time: 20 minute prep time
50 -80 minutes (not counting writing)

Materials:

- 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
- For "Farmer's Market Solar System (Class Demo) - <u>or use cutouts</u>
  - 1 Honeydew Melon
  - 1 Cantaloupe
  - 1 Lemon
  - 1 Lime
  - 2 Grapes
  - 1 Macadamia Nut
  - 3 Peppercorns
- All Templates
- Pens/Pencils
- Writing Journals

Objectives:

1. Students will learn about their solar system and the relative size of the planets.
2. Students will learn about the distances between planets.
3. Students will learn that science is all about not knowing at first, but finding ways (e.g., using models, making predictions) to gain new knowledge.

Activity (step by step):

STEP 1: ENGAGE (~10 minutes) Making Predictions.

1. 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 the 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, 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.
2. 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.

STEP 2: EXPLORE (~20 minutes) Finding the Scale.

1. Hand out the Solar System Beads Instruction Sheet and the Planet Beads Calculation Worksheet.
2. Have students complete the table in the Planet Beads Calculation Worksheet, converting the various AU distances to centimeters, and complete the chart provided.
3. Have students measure and cut a piece of string 4.5 meters long.
4. Using the calculated cm distances, tie the bead onto the string using a double knot.
5. When students finish the activity, review the models, then wrap the Solar System string (with beads) around the cardboard holder.
6. 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.

1. Have students complete the questions on Student Handout #2 and discuss as a group.

STEP 4: ELABORATE (optional ~25 minutes)

1. For this step, allow students to examine the fruits, nuts, and peppercorns (or cutout 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 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.
2. Once students are finished, using Farmer's Market Solar System Key, reveal the Farmer's Market Solar System for students to compare their results.
3. By completing the final two questions on 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.

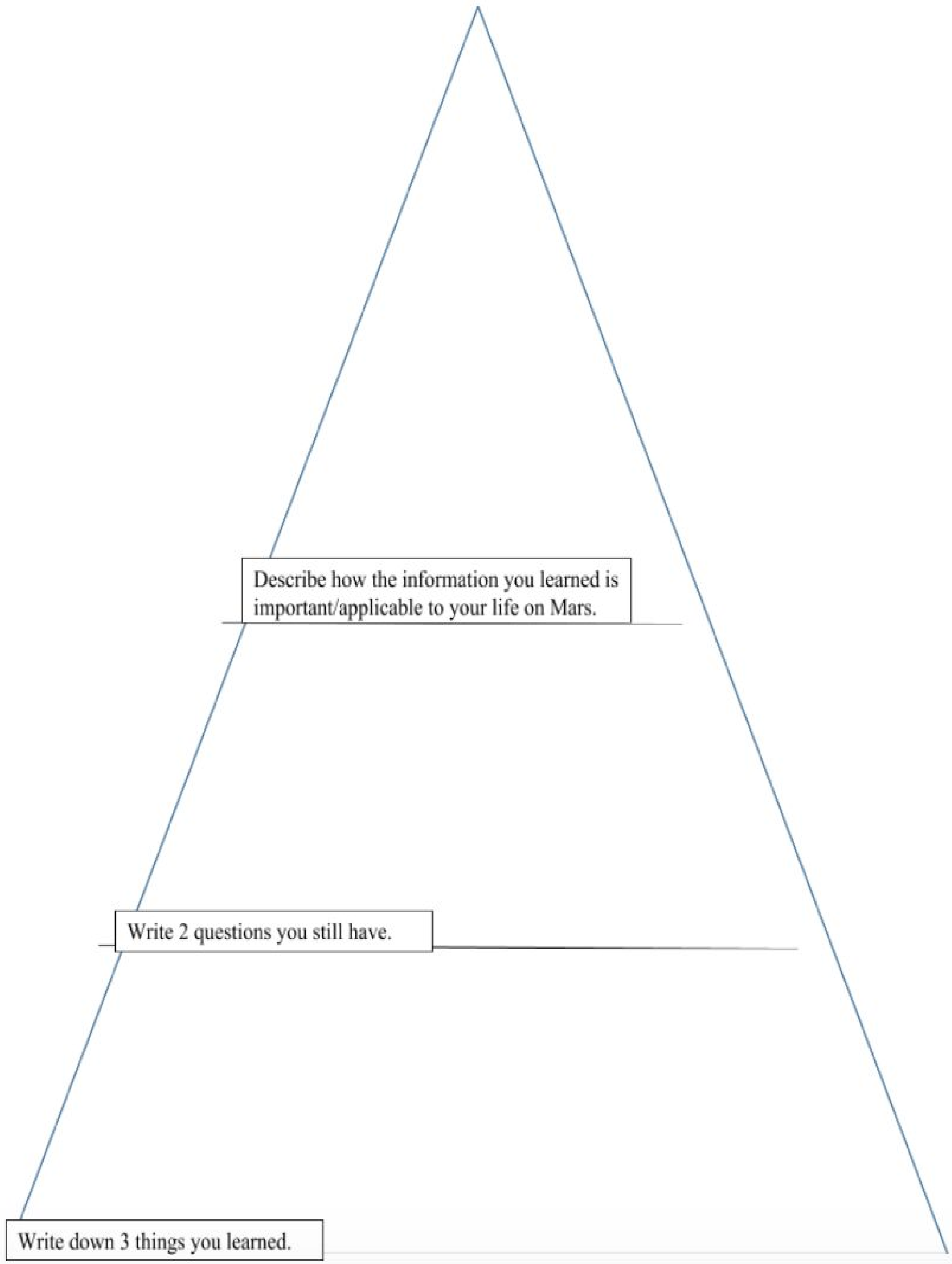
Extension (optional, 5 minutes)

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.

STEP 6: WRITING

1. Writing to Learn – Use the 3-2-1 Pyramid Model (See Template) to reflect on today's activities.

3-2-1 Pyramid Model for Learning



Mars Habitation (STUDENT HANDOUTS)

Student Handout #1 - Solar System Predictions

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

Prediction 1:	Prediction 2:

Student Handout #2 - 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.

Student Guide - 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 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?

Student Guide - 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.

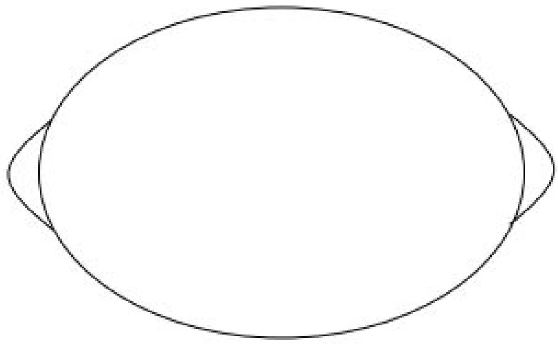
Planet	**Object**	**Justification**
Mercury		
Venus		
Earth		
Moon		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		
(Pluto)		

Your Place on Mars (TEACHER HANDOUTS)

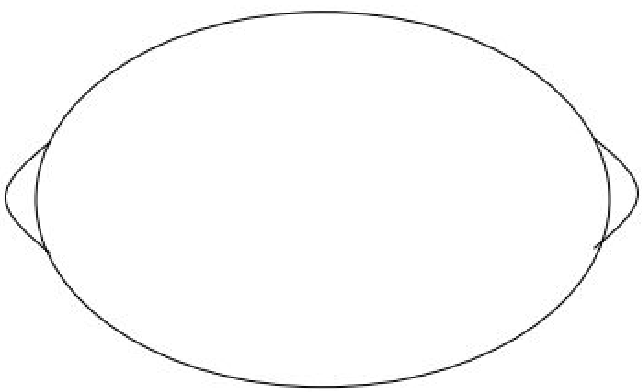
Teacher Guide - Teacher Resource. Farmer’s Solar System Key

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

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

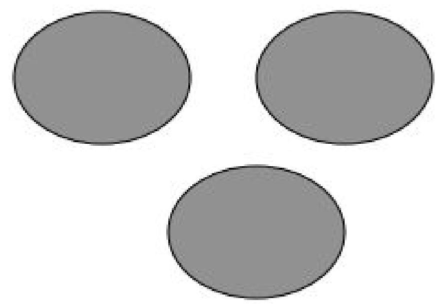


Lime

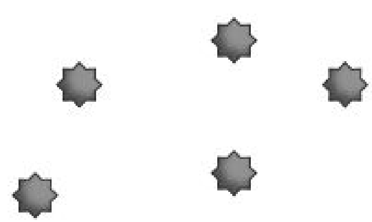


Lemon

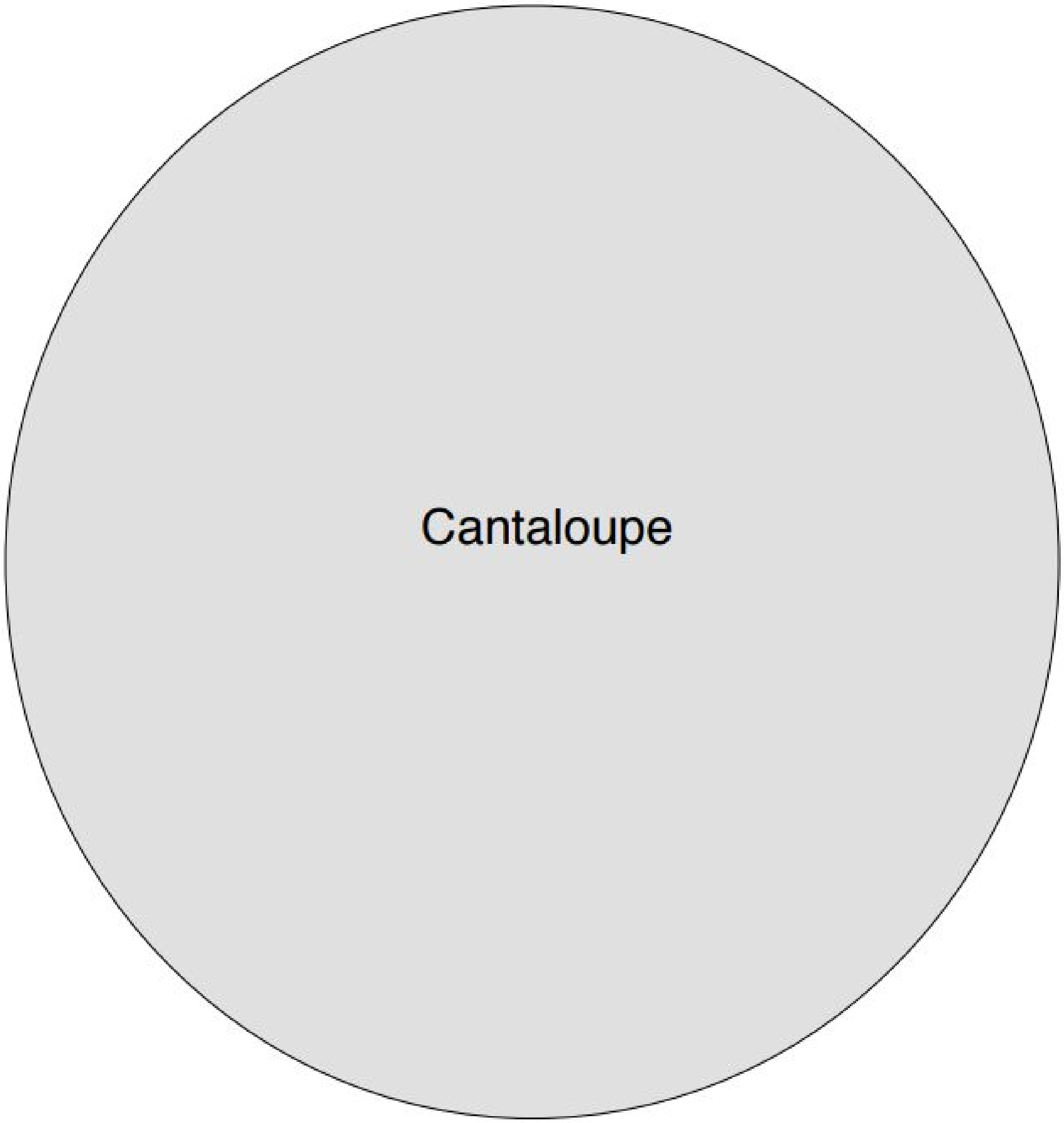
Macadamia Nut



Grapes



Peppercorns


Cantaloupe

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