A Solar System Model

Overview:

Students examine the distances between the objects in our solar system and demonstrate a small-scale model of the sun, eight planets, and Pluto.

Objectives:

The student will:
- use research skills;
- calculate scale; and
- demonstrate a scaled model of the sun and planets in our solar system.

Materials:

- Map of Alaska
- Ball (8 inch diameter)
- 3 pinheads (0.03 inch diameter each)
- 2 peppercorns (0.08 inch diameter each)
- Chestnut or pecan (0.90 inch diameter)
- Hazelnut or acorn (0.70 inch diameter)
- Two peanuts or coffee beans (0.30 inch diameter ea.)
- Names of the planets, Pluto and the sun written on 10 white index cards
- Measuring tape
- Camera (optional)
- Butcher paper (optional)
- STUDENT WORKSHEET: "Scale of the Solar System"

Activity Procedure:

1. Before the lesson gather the ball, pinheads, peppercorns, chestnut or pecan, hazelnut or acorn, two peanuts or coffee beans, and 10 white index cards with the names of the planets, Pluto and the sun written on them. If these exact items are not available, look for other items of the same size or cut out circles from a piece of paper. The items do not need to be perfectly round.
2. Ask students to think about the size of the universe. Explain that light travels at 300 million meters per second, and yet it still takes many years for it to travel through space.
3. Discuss location and size by writing down the class "galactic address." Label each unit of the address (street, town, state, country, etc.). Start with the street, moving up in scale. For example, if you are on Koyukuk Drive in Bethel, your "galactic address" would be:

    Koyukuk Drive, Bethel, Alaska, United States, North America, Earth,
    Solar System, Milky Way Galaxy

4. Explain that beyond our galaxy there are many other galaxies. The Andromeda galaxy is 2.2 million light-years from ours and is our nearest neighbor. Scientists do not know the size of the Universe, although they have many theories. The furthest galaxy known to us is 13 billion light years away.

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5. It is easier to understand large distances when they are viewed on a smaller scale. Show a map of Alaska and explain that the actual state of Alaska is much bigger than the map. The map of Alaska is a representation of Alaska on a much smaller scale. It is a useful tool, providing such information as the distance from Fairbanks to Barrow in comparison with Anchorage.
6. Students will make a model of the solar system, with the sun, planets and Pluto. Because the solar system is so huge, the scale of the model will have to be very small, and even then it still will not fit inside the classroom. For this exercise, the solar system will be built to a scale of 1 pace for 100,000,000 kilometers.
7. Take the class outside. Hand a different student each of the following ten items and the index card that goes with that item:
   a. Sun – ball
   b. Mercury – a pinhead
   c. Venus – a peppercorn
   d. Earth – a second peppercorn
   e. Mars – a second pinhead
   f. Jupiter – a chestnut or pecan
   g. Saturn – a hazelnut or acorn
   h. Uranus – a peanut or coffee bean
   i. Neptune – a second peanut or coffee bean
   j. Pluto – a third pinhead
8. Explain that because the scale for this lesson is 1 pace to 100,000,000 kilometers, it will take over 50 paces to walk the distance from the sun to Pluto. Call out a planet and a number of paces. The student with that planet should start at the spot designated as the sun and walk the correct number of paces then stop and stay there.
9. Call out each planet in turn with the follow number of spaces.
   a. Sun – 0 paces
   b. Mercury – 0.5 paces
   c. Venus – 1 paces
   d. Earth – 1.5 paces
   e. Mars – 2 paces
   f. Jupiter – 8 paces
   g. Saturn – 14 paces
   h. Uranus – 29 paces
   i. Neptune – 45 paces
   j. Pluto – 59 paces

   When all the planets and Pluto are in place, tell students to hold up the planets and signs to get an idea of the distances between objects in our solar system. Good chance to take a picture!
10. Once back in the classroom, explain that with that conceptual idea of how large our solar system is, students can find the actual distance between the planets and then calculate their distances based on a scale.
11. Ask students to complete the STUDENT WORKSHEET: "Scale of the Solar System."

Teacher's Note—The Status of Pluto: In August 2006, the International Astronomical Union (IAU) General Assembly agreed on the definition of "planet." A planet is a celestial body that (a) is in orbit around the sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighborhood around its orbit. According to this definition, Pluto is no longer classified at a planet. Pluto is now considered a dwarf planet. *Source: "IAU0603: IAU 2006 General Assembly: Result of the IAU Resolution Votes." 24 August 2006. http://www.iau.org/iau0603.414.0.html. Accessed 11 January 2007.*

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Extension Idea: Assign students to cut out circles that measure the scaled sizes of the sun or planets. Butcher paper, or some large piece of material, will be necessary for the sun. Hold them up together to get an idea of the size.

Answers to Student Questions:

Hypothesis: Answers will vary.

Data:

1. *Answers will vary.*

2.

	Average Distance from the Sun (kilometers)
Mercury	*57,900,000*
Venus	*108,200,000*
Earth	*149,600,000*
Mars	*227,900,000*
Jupiter	*778,600,000*
Saturn	*1,433,500,000*

Analysis of Data: 1. 5,870,000,000, 2-4. Answers will vary.

Conclusion: Answers will vary.

Further Questions: 1. 1,000; 2. Answers will vary.

3.

	Diameter (kilometers)	*Scaled Distance (mm)*
Sun	*1,392,000*	*1,392*
Mercury	*4,879*	*4.9*
Venus	*12,104*	*12.1*
Earth	*12,756*	*12.8*
Mars	*6,794*	*6.8*
Jupiter	*142,984*	*143*
Saturn	*120,536*	*120.5*
Uranus	*51,118*	*51.1*
Neptune	*49,528*	*49.5*
Pluto	*2,390*	*2.4*

Name: ___________________________________

Scale of the Solar System

Testable Question:

Our solar system is vast. What scale could be used to fit the solar system inside the classroom?

Hypothesis:

The solar system would need to be scaled at __________ to _________ to fit inside the classroom.

Data:

1. The length of the classroom is ___________________ meters.
2. Fill in the table below, using the Internet and other classroom resources to find the answers. Write your answer in kilometers. You may need to convert meters to kilometers. If so, remember 1 meter (m)= 1,000 kilometers (km).

Planet	Average Distance from the Sun (km)
Mercury	
Venus	
Earth	
Mars	
Jupiter	
Saturn	
Uranus	
Neptune	
Pluto (a dwarf planet)	

Analysis of Data:

1. The farthest distance, the sun to Pluto, is ____________________ km.
2. To calculate the scale needed to fit inside the classroom, we must divide the distance of the sun to Pluto by the length of the classroom.

   __________________ ÷ ____________________ = ________________

   (distance of sun to Pluto) (length of classroom)

3. So, the scale needed is ____________ *(answer from #1)* = ___________ *(answer from #2)*.

We can make these numbers smaller by dividing by a common number. For example, if our scale was 8 m = 8000 km, we could divide each side by 8.

8 m ÷ 8 = 1 m
8000 km ÷ 8 = 1000 km
So, our scale would become 1 m = 1,000 km.

4. Reduce your scale to the lowest possible numbers and record the scale here:__________________.

Scale of the Solar System

Conclusion:

1. Was your hypothesis correct or incorrect? ________________________________

2. The solar system would need to be scaled at __________to __________ to fit inside the classroom.

Further Questions:

1. How many millimeters are in one meter? ____________________

2. Now that you have a scale, fill in the chart below, using your scale.

Planet	Average Distance from the Sun (km)	Scaled Distance (unit = ______)
Mercury		
Venus		
Earth		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		
Pluto		

3. Research the diameter of the sun and the following planets including Pluto. Next, calculate the scaled size using 1 millimeter to 1,000 kilometers.

Object	Diameter (km)	Scaled Distance (mm)
Sun		
Mercury		
Venus		
Earth		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		
Pluto		

