The NASA SCI Files™
The Case of the
Galactic Vacation

Segment 1

The tree house detectives receive an assignment to create an "out-of-this-world" vacation. With billions of places in the universe to go, the detectives have different ideas about the best destination. They finally agree to divide into teams and research three different "docks-of-call," the Moon, Mars, and a distant star. They head to Dr. D's lab to learn a little more about the planets in our solar system and discover that objects in the universe are really far apart. Going some distance herself, Bianca travels to Puerto Rico for an internship at the largest radio telescope in the world, Arecibo Observatory. She promises to do research for the assignment while there, and her first task is to get some help from her cousin's class at the Antonio Gonzalez Suarez Bilingual School in Añasco, Puerto Rico. Ms. Alice Acevedo's class shows the tree house detectives how to measure distances in space using parallax. Mentors from the Society of Women Engineers (SWE) also assist the class.

Objectives

The students will
• identify and describe objects in our solar system.
• create a scale model of our solar system using astronomical units.

• understand how astronomers measure distance in space.

Vocabulary

inner planets–the four solid, rocky planets closest to the Sun—Mercury, Venus, Earth, and Mars

light-year–a unit of length in astronomy equal to the distance that light travels in one year or 9,458,000,000,000 kilometers

outer planets–the five planets farthest from the Sun—Jupiter, Saturn, Uranus, Neptune, Pluto

parallax–the apparent shift in position of an object as seen from two different points not on a straight line with the object

planet–a heavenly body other than a comet, asteroid, or satellite that travels in orbit around the Sun; also such a body orbiting another star

solar system–a star with the group of heavenly bodies that revolve around it; especially the Sun with the planets, asteroids, comets, and meteors that orbit it

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 1 of *The Case of the Galactic Vacation*, read the program overview (p. 5) to the students. List and discuss questions and preconceptions that students may have about the solar system, stars, and how to measure distances in space.

2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them to

better understand the problem. The following tools are available in the educator area. To locate them, click on the educator's menu bar, then click on "Tools" and then "Instructional Tools." You will find them listed under the "Problem-Based Learning" tab.

Problem Board–Printable form to create student or class K-W-L chart

Guiding Questions for Problem Solving–Questions for students to use while conducting research

Problem Log & Rubric–Printable log for students with the stages of the problem-solving process

Brainstorming Map–Graphic representation of key concepts and their relationships

The Scientific Method and Flow Chart–Chart that describes the scientific method process

3. Focus Questions–Questions at the beginning of each segment that help students focus on a reason for viewing and can be printed ahead of time from the educator's area of the web site in the "Activities/Worksheet" section under "Worksheets." Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to answer the questions. An icon will appear when the answer is near.

4. What's Up? Questions–Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the educator's area of the web site in the "Activities/Worksheet" section under "Worksheets."

View Segment 1 of the Video

Careers

astronomer
aerospace worker
mathematician
physicist
planetologist

For optimal educational benefit, view *The Case of the Galactic Vacation* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.

2. Discuss the Focus Questions.

3. Students should work in groups or as a class to discuss and list what they know about our solar system, stars, and distances in space. Have the students conduct research on the solar system and brainstorm which planet the tree house detectives should choose as their destination. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide students with the information needed.

4. Have the students complete Action Plans, which can be printed from the educator area or the tree house's "Problem Board" area in the "Problem-

Solving Tools" section of the web site for the current online investigation. Students should then conduct independent or group research by using books and internet sites noted in the "Research Rack" section of the "Problem Board" area in the tree house. Educators can also search for resources by topic, episode, and media type under the Educator's main menu option Resources.

5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.

6. Have the students work individually, in pairs, or in small groups on the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on the tree house and then the "Problem Board." Choose the "2002-2003 Season" and click on *Suspicious Sickness.*

   • To begin the PBL activity, read the scenario (Here's the Situation) to the students.

   • Read and discuss the various roles involved in the investigation.

   • Print the criteria for the investigation and distribute.

   • Have students use the "Research Rack" and the "Problem-Solving Tools" located on the bottom menu bar for the PBL activity. The "Research Rack" is also located in the tree house.

7. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess the students. In the beginning, students may have difficulty reflecting. To help students, give them specific questions to reflect upon that are related to the concepts.

8. Have students complete a Reflection Journal, which can be found in the Problem-Solving Tools section of the online PBL investigation or in the Instructional Tools section of the Educator's area.

9. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Resources (additional resources located on web site)

Books

Branley, Franklyn Mansfield: *The Planets in Our Solar System (Let's-Read-and-Find-Out Science, Stage 2).* HarperTrophy, 1998, ISBN: 006445178X.

Cole, Joanna: *The Magic School Bus Lost in the Solar System.* Scholastic Trade, 1992, ISBN: 0590414291.

Egan, John: *Solar System.* Golden Books Family Entertainment, 1999, ISBN: 0307204073.

Leedy, Loreen: *Postcards from Pluto: A Tour of the Solar System.* Holiday House, 1996, ISBN: 0823412377.

L'Hommedieu, Arthur John: *Children of the Sun.* Child's Play International, Ltd., 1994, ISBN: 0859539318.

Ride, Sally and Tam O'Shaughnessy: *Voyager: An Adventure to the Edge of the Solar System (Face to Face With Science).* Crown Publishers, Inc., 1992, ISBN: 0517581574

Simon, Seymour: *Our Solar System.* William Morrow & Company, 1992, ISBN: 0688099920.

Simon, Seymour: *Stars.* Mulberry Books, 1989, ISBN: 0688092373.

Simon, Seymour: *The Sun.* Mulberry Books, 1989, ISBN: 0688092365.

Video

Eyewitness—*Planets* (1997), ASIN: 0789421488

Web Sites

NASA Spacelink—Where to Find Information on the Solar System and Universe
With all the resources available at NASA, finding specific information related to the solar system can be a daunting task. You know that you won't find information on an asteroid in the same place you'll find the diameter of Jupiter. So where's the best place to look? The answer is NASA Spacelink! Spacelink has categorized the different areas of space science to make information easier to locate. *http://spacelink.nasa.gov/focus/Articles/010_Solar_System/*

Our Solar System
Come along and explore our amazing solar system. Here, students will journey far into space to learn interesting facts about planets, objects in our solar system, and even how to become an astronaut! *http://www.montana.edu/4teachers/instcomp/hunts/science/Solar/SpaceHunt.html*

Kids Astronomy
Great web site created for both the student and the educator. Learn how big the universe is by clicking your way through the universe in powers of ten. http://www.KidsAstronomy.com/

Activities and Worksheets

Scaling the Solar System

Purpose
To understand an astronomical unit
Create a model demonstrating the scale distances of the solar system by using astronomical units

Materials

4.5-m string
meter sticks
beads of 11 different
    colors
small cup to hold
    beads
marker

Teacher's Note It is important to realize that the sizes of the planets are not to scale. Jupiter's diameter is about 63 times that of Pluto, and the Sun's diameter is about 10 times that of Jupiter. On the scale of 1 AU = 10 cm, the Sun would only be 1 mm in diameter, and the planets would be mere dots.

Background
Astronomers have chosen a unit to measure distances in space called the astronomical unit (AU). The length of an astronomical unit is the average distance of the Earth from the Sun. The distance is about 93,000,000 miles (mi) or 150,000,000 kilometers (km). Using the 150,000,000 km as one astronomical unit, create a model solar system.

Procedure

1. Determine the color bead to represent each planet and the asteroid belt and record in chart below. Save a yellow bead to represent the Sun.
2. Complete the chart to determine each planet's astronomical unit.
3. Using the scale of 1 AU = 10 centimeters (cm), determine the distance in cm and complete the chart. Multiply the AU by 10 cm.
4. Attach the Sun bead on one end of the string and secure with a knot.
5. Use a meter stick and measure the distance from the Sun determined in the chart for Mercury and mark.
6. Slide the bead onto the string to the mark and secure with a knot.
7. Repeat for each of the other planets and the asteroid belt.

AU Chart

Planet	Bead Color	Distance in million of km (Average)	÷ 150	Relative Distance (AU)	Rounded to the nearest tenth	Distance in cm (AU) x 10 cm
Mercury		57	÷ 150			
Venus		108	÷ 150			
Earth		150	÷ 150			
Mars		228	÷ 150			
Asteroid Belt		420	÷ 150			
Jupiter		778	÷ 150			
Saturn		1,427	÷ 150			
Uranus		2,280	÷ 150			
Neptune		4,497	÷ 150			
Pluto		5,900	÷ 150			

Extension

1. Create a solar system in the classroom and/or on the playground by using a different scale for the AU of each planet.
2. Conduct research to learn more about asteroids and how they differ from planets.

Conclusion

1. Why do astronomers need astronomical units to measure distances in space?
2. Which planets are the inner planets? Outer planets?
3. What separates the inner planets from the outer planets?
4. Explain a scale model and why it was useful.

Planning the Planets

Planetary Data Chart

| Planet	Distance from the Earth in millions of km (avg)	Distance from the Sun in millions of km	Diameter	Mass Ratio with Earth	Temperature	Gravity	Length of Day	Length of Year	Satellites	Tilt
Mercury	91.7	57.9	4,880 km	0.055	-170˚– 350 ˚ C	0.39	59 days	88 days	0	0˚
Venus	41.4	108.2	12,104 km	0.815	465˚ C surface	0.91	243 days	225 days	0	177.3˚
Earth	0	149.6	12,576 km	1.0	15˚ C avg. surface	1	23 hrs, 56 min	365 days	1	23.5˚
Mars	78.3	227.9	6,787 km	0.11	-23˚ C avg surface	0.38	24 hrs, 37 min	687 days	2	24˚
Jupiter	628.7	778.3	142,800 km	318	-150˚ C at cloud tops	2.60	9 hrs, 55 min	11.9 years	28	3.1˚
Saturn	1,277	1,427	120,600 km	95.2	-180˚ C at cloud tops	1.07	10 hrs, 42 min	29.5 years	30	26.7˚
Uranus	2,721	2,870	51,300 km	15	-210˚ C at cloud tops	0.90	17 hrs, 12 min	84 years	21	97.9˚
Neptune	4,347	4,497	49,100 km	17	-220˚ C at cloud tops	1.15	16 hrs, 6 min	165 years	8	29.6˚
Pluto	5,750	5,900	2,200 km	0.002	-220˚ C avg. surface	0.03	6 days, 9 hrs	248 years	1	118˚

Using the Planetary Data Chart, create bar graphs in your science journal showing
• the number of satellites each planet has.
• the diameter of each planet.
• your choice.

Planning the Planets (concluded)

Venn Diagram

Use the Planetary Data Chart to complete the Venn diagram.

Tilt is less than 30˚ — *Has Satellites*

Larger than Earth — *Gravity is greater than 1*

Has Satellites
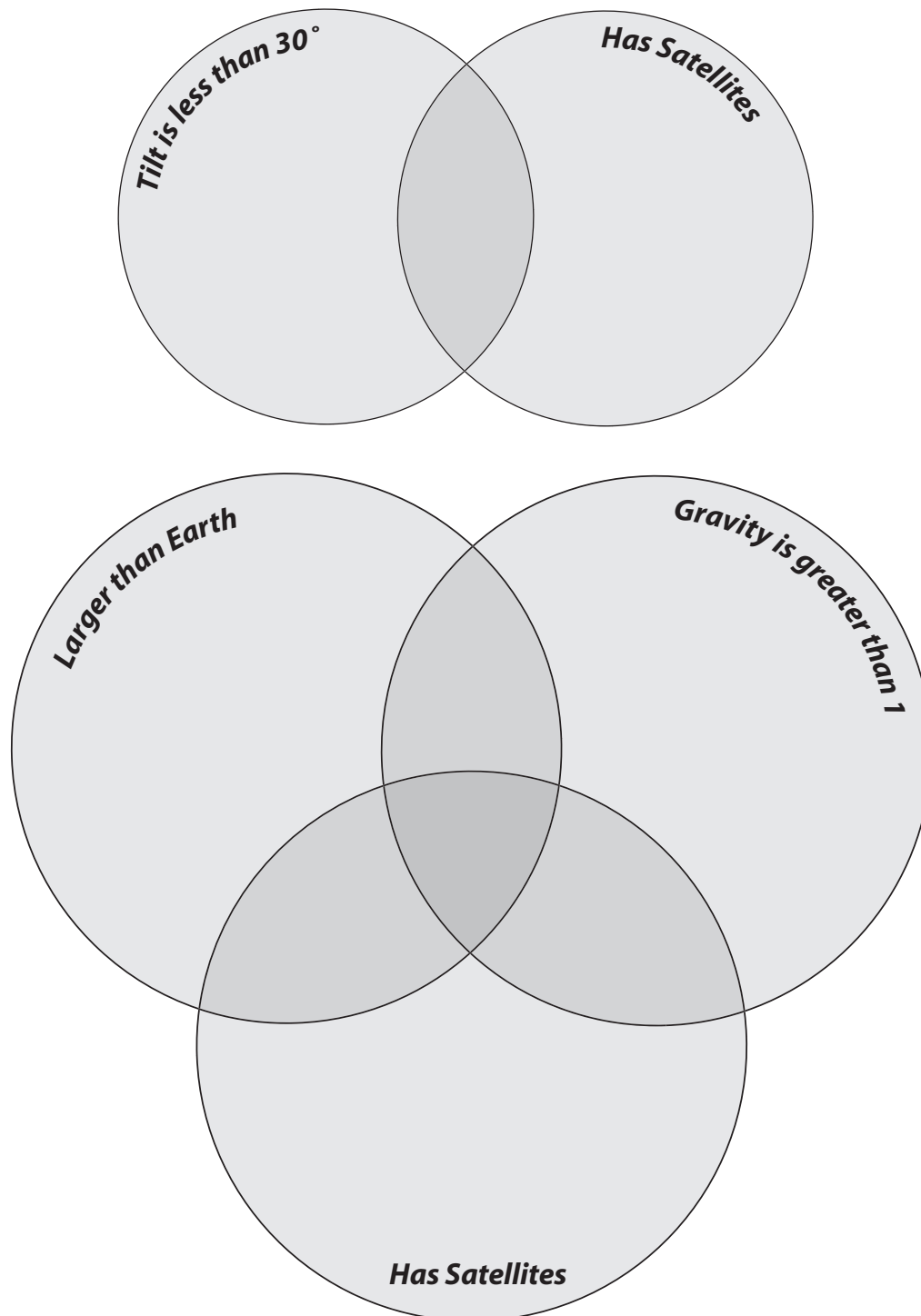
A Long Walk in the Dark

Purpose

To determine the length of time it takes to walk, drive, and fly to the Moon and planets

Procedure

1. Using the average distance from Earth, calculate the number of hours it will take you to walk, drive, and fly to the Moon and the other planets.
2. Convert the number of hours into years by using 24 hours in a solar day and complete the chart below. The first one is done for you.

Materials

calculator
pencil
science journal

> **Moon Example**: 384,000 km ÷ 3.6 km/h = 106,667 hours
> 365 days x 24 hours = 8,760 hours per year
> 106,667 hours ÷ 8,760 hours per year = 12.17 years
> Round to the nearest year = 12 years

3. Calculate the age you will be if you left today and flew to the Moon and each planet. Your current age + the number of years = future age

Heavenly Body Average Distance	Walking 3.6 km/h	Walking Years	Driving 80 km/h	Driving Years	Flying 1,436 km/h	Flying Years	My Future Age
Moon 384,000 km	106,667 hours	12 years	4,800 hours	0.5 years	267 hours	0.03 years	
Mercury 92,000,000 km							
Venus 41,000,000 km							
Mars 78,000,000 km							
Jupiter 629,000,000 km							
Saturn 1,227,000,000 km							
Uranus 2,721,000,000 km							
Neptune 4,347,000,000 km							
Pluto 5,750,000,000 km							

Conclusion

1. With the distances between planets being so great, will it be possible to travel to them in the future? Why or why not?
2. Which planet would you like to visit? Why?

What a Parallax!

Purpose   To understand how astronomers measure the distance to stars

Teacher Prep   If necessary, work with students to familiarize them with how to use a protractor.

Procedure

1. Using the red marker, color one end of the rope approximately 5 cm. This will be end "A."
2. Using the blue marker, color the opposite end of the rope approximately 5 cm. This will be end "B."
3. In a large open area, lay the rope in a straight line. This will be your baseline.
4. Place a large object, such as a chair, some distance away from the rope. A tree, flagpole, or shrub may also be used, but the object must not be more than 25 m from the baseline (rope).
5. Stand at position "A" and hold the protractor so that it is parallel to the baseline.
6. Place your pencil on the inside of the protractor and move it along the curve until it lines up with the object. See diagram 1.
7. Being very careful not to move your pencil, have your partner read and record the angle measurement.
8. Have your partner repeat steps 5-7 at position "B."
9. On a sheet of graph paper along the very bottom, draw a line 10 cm long to represent your baseline. NOTE: For this exercise, let the scale be 1 m = 1 cm.
10. Mark one end of the drawn line as "A" and the other end as "B."
11. At point "A" measure an angle that is the same number of degrees as the angle outside for point "A." Mark and draw the angle.
12. At point "B" measure an angle that is the same number of degrees as the angle outside for point "B." Mark and draw the angle. See diagram 2.
13. The two lines should intersect. Mark the point of intersection as point "C."
14. Draw a line perpendicular from point "C" to the baseline.
15. Measure the distance of this perpendicular line.
16. Using the scale 1 m = 1 cm, determine the distance the object was from the baseline.

Conclusion

1. Why do astronomers use parallax to determine the distance to stars?
2. Name several situations when you might want to use parallax on Earth.

Extension   Use a different scale and determine distances of points farther away.

Materials

protractor
notebook paper
red marker
blue marker
10-m rope
pencil
large outside area
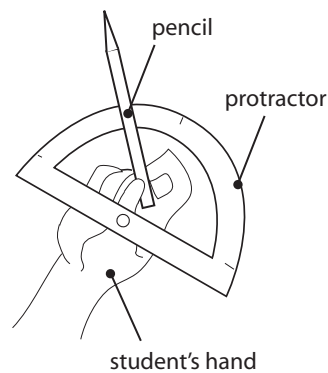large object
metric ruler
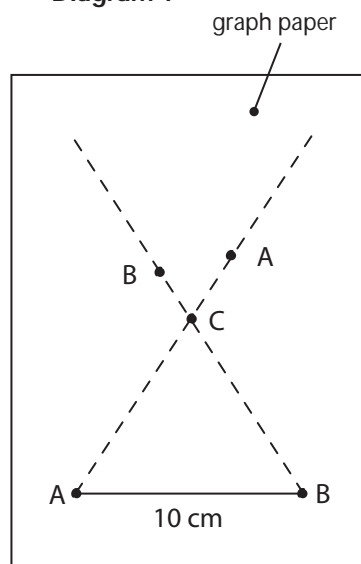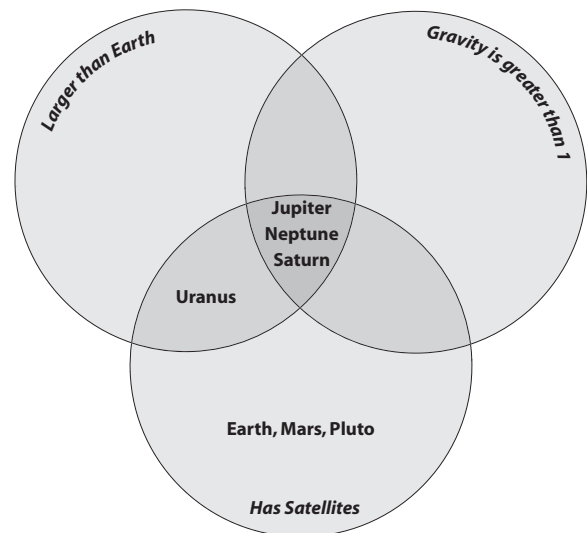graph paper
science journal
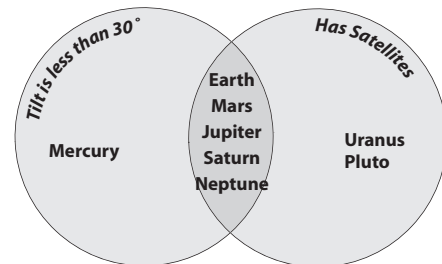

Diagram 1

Diagram 2

Answer Key

Scaling the Solar System

AU Chart

Planet	Bead Color	Distance in millions of km	÷ 150	Relative Distance (AU)	Rounded to the nearest tenth	Distance in cm (AU) x 10 cm
Mercury		57	÷ 150	0.38	0.4	4 cm
Venus		108	÷ 150	0.72	0.7	7 cm
Earth		150	÷ 150	1	1.0	10 cm
Mars		228	÷ 150	1.52	1.5	15 cm
Asteroid Belt		420	÷ 150	2.8	2.8	28 cm
Jupiter		778	÷ 150	5.18	5.2	52 cm
Saturn		1,427	÷ 150	9.51	9.5	95 cm
Uranus		2,280	÷ 150	19.13	19.1	191 cm
Neptune		4,497	÷ 150	29.98	30.0	300 cm
Pluto		5,900	÷ 150	39.33	39.3	393 cm

1. Astronomers need astronomical units (AU) to measure distances in space because the distances are so great. If miles or kilometers were used, they would be huge numbers and difficult to work with. Astronomical units help to simplify the measurements. The AU, comes from early times when astronomers could only measure distances to planets relative to the AU, and they didn't know the size of the AU.

2. The inner planets are Mercury, Venus, Earth, and Mars. The outer planets are Jupiter, Saturn, Uranus, and Pluto.

3. A large space with an asteroid belt separates the inner planets from the outer planets.

4. Scientists use models everyday. Models can be conceptual, mathematical, and scale. The solar system is so large we must use a scale to better understand the relationship between the Sun and the planets and to better understand the great distances in space.

Planning the Planets

Tilt is less than 30° / *Has Satellites*

Earth
Mars
Jupiter
Saturn
Neptune

Mercury

Uranus
Pluto

Larger than Earth / *Gravity is greater than 1*

Jupiter
Neptune
Saturn

Uranus

Earth, Mars, Pluto

Has Satellites

Answer Key (concluded)

A Long Walk in the Dark

Heavenly Body Average Distance	Walking 3.6 km/h	Walking Years	Driving 80 km/h	Driving Years	Flying 1,436 km/h	Flying Years	My Future Age
Moon 384,000 km	106,667 hours	12 years	4,800 hours	0.5 years	267 hours	0.03 years	
Mercury 92,000,000 km	25,555,555	2,917	1,150,000	131	64,067	7	
Venus 41,000,000 km	11,388,888	1,300	512,500	59	28,551	3	
Mars 78,000,000 km	21,666,666	2,473	975,000	111	54,318	6	
Jupiter 629,000,000 km	174,722,222	19,945	7,862,500	898	438,022	50	
Saturn 1,227,000,000 km	340,833,333	38,908	15,337,500	1,751	854,456	98	
Uranus 2,721,000,000 km	755,833,333	86,282	34,012,500	3,883	854,456	216	
Neptune 4,347,000,000 km	1,207,500,000	137,843	54,337,500	6,203	3,027,159	346	
Pluto 5,750,000,000 km	1,597,222,222	182,331	71,875,500	8,205	4,004,178	457	

What a Parallax!

1. Currently there is no physical way to measure the distance to nearby stars. The apparent shift in the position of an object when viewed from two different positions offers an observer an easy way to measure the distance.

2. Answers will vary but might include a distant building, tree, or mountain.