National Aeronautics and
Space Administration

Langley Research Center
Hampton, VA 23681-2199

Educational Product	
Educators	Grades 3-5

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The NASA SCI Files™
The Case of the Galactic Vacation

A Lesson Guide with Activities in Mathematics, Science, and Technology

Please Note: Our name has changed! The NASA "Why" Files™ is now the NASA SCIence Files™ and is also known as the NASA SCI Files™.

http://scifiles.larc.nasa.gov

The Case of the Galactic Vacation lesson guide is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site: **http://scifiles.larc.nasa.gov**

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www.swe.org

www.buschgardens.com

www.cnu.edu

www.epals.com

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http://quest.arc.nasa.gov

NEC Foundation of America

www.nec.com

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Segment 1

Segment 2

Segment 3

Segment 4

For additional information about the NASA SCI Files™, contact Shannon Ricles at (757) 864-5044 or **s.s.ricles@larc.nasa.gov**.

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Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kim.tholen@swe.org**

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Program Overview

In *The Case of the Galactic Vacation*, 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. To begin their investigation, they go to Dr. D's lab to learn about the solar system. After realizing that objects in space are really far apart, the tree house detectives decide that they need to learn more about how to measure distances in space. Going some distance herself, Bianca travels to Puerto Rico for an internship at the world's largest radio telescope, Arecibo Observatory. She goes to her cousin's 5th grade class at the Antonio Gonzalez Suarez Bilingual School in Añasco, Puerto Rico where the students and their mentors from the Society of Women Engineers (SWE) demonstrate how to measure distance in space using parallax.

The tree house detectives decide that they need to learn more about working and living in space, so they contact NASA Johnson Space Center and are able to speak with the International Space Station (ISS) Expedition Six astronaut crew. From there the detectives decide that the Moon would be a perfect place to go, and they talk with Ed Prior from NASA Langley Research Center, who explains the Moon's unique features and its phases. The detectives continue to wonder about unusual alien environments and what is necessary to live in them. They seek the expertise of Dr. D, who helps them better understand the vast differences among the planets and other objects. Then it is off to learn about Mars, and they speak with Robert Braun with NASA Langley Research Center.

After learning that a trip to Mars could take longer than six months, the tree house detectives decide to learn more about traveling in space. They meet Dr. D at Busch Gardens in Williamsburg, Virginia to ride a few roller coasters and learn about gravity, acceleration, and weightlessness. Next stop is Starship 2040, where Mr. Wang of NASA Marshall Space Flight Center explains what tourism in space will be like in about 50 years. Now the detectives realize that no matter where they go in the solar system or galaxy, the current rocket system will not get them there and back quickly enough. They head off to speak with Dr. Franklin Chang-Diaz of NASA Johnson Space Center to learn more about plasma rockets for the future.

As the tree house detectives wind up their investigation, they call on Bianca at Arecibo to learn more about the stars and galaxies. Dr. D, who just happens to be at Arecibo, gives Bianca a visual tour of the night sky. Dr. Daniel Altschuler, Dr. Tapasi Ghosh, and Dr. Jose Alonso who conduct research at Arecibo, help the tree house detectives understand how radio telescopes work and how they are used to study the stars, planets, and other objects in the universe. After a successful internship and a great time in Puerto Rico, Bianca heads home to help the rest of the detectives wrap up their project and create an "out-of-this-world" vacation.

National Science Standards (Grades K – 4)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
Systems, orders, and organization	×	×	×	×
Evidence, models, and explanations	×	×	×	×
Change, constancy, and measurement	×	×	×	×
Form and Function	×	×	×	×
Science as Inquiry (Content Standard A)				
Abilities necessary to do scientific inquiry	×	×	×	×
Understanding scientific inquiry	×	×	×	×
Life Science (Content Standard C)				
Organisms and their environments		×	×	
Earth and Space Science (D)				
Properties of Earth materials	×			
Objects in the sky	×	×	×	×
Changes in Earth and sky	×	×		×
Science in Personal and Social Perspective (Content Standard F)				
Personal health			×	
Changes in environment		×	×	
Science and technology in local challenges		×	×	
History and Nature of Science (Content Standard G)				
Science as a human endeavor	×	×	×	×

National Science Standards (Grades 5 – 8)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
Systems, order, and organization	X	X	X	X
Evidence, models, and explanations	X	X	X	X
Change, constancy, and measurement	X	X	X	X
Form and Function	X	X	X	X
Science as Inquiry (Content Standard A)				
Abilities necessary to do scientific inquiry	X	X	X	X
Understanding scientific inquiry	X	X	X	X
Physical Science (B)				
Properties and changes of properties in matter	X	X	X	X
Position and motion of objects	X	X	X	X
Transfer of energy	X	X	X	X
Earth and Space Science (D)				
Structure of the Earth system	X			
Earth's history		X		
Earth in the solar system	X	X	X	X
Science and Technology (Content Standard E)				
Abilities of technological design	X	X	X	X
Understanding science and technology	X	X	X	X
Science in Personal and Social Perspectives (Content Standard F)				
Personal health			X	
Risks and benefits			X	
Science and technology in society	X	X	X	X
History and Nature of Science (Content Standard G)				
Science as a human endeavor	X	X	X	X
Nature of science	X	X	X	X
History of science	X	X	X	X

National Mathematics Standards (Grades 3 - 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Number and Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	x	x	x	x
Understand meanings of operations and how they relate to one another.	x	x	x	x
Compute fluently and make reasonable estimates.	x	x	x	x
Algebra				
Understand patterns, relations, and functions.	x	x		x
Use mathematical models to represent and understand quantitative relationships.	x	x		x
Geometry				
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.	x	x	x	
Specify locations and describe spatial relationships by using coordinate geometry and other representational systems.	x	x		
Use visualization, spatial reasoning, and geometric modeling to solve problems.	x			
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	x	x	x	x
Apply appropriate techniques, tools, and formulas to determine measurements.	x	x	x	x
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	x	x	x	x
Select and use appropriate statistical methods to analyze data.	x			
Develop and evaluate inferences and predictions that are based on data.	x			
Understand and apply basic concepts of probability.	x			
Problem Solving				
Build new mathematical knowledge through problem solving.	x	x	x	
Solve problems that arise in mathematics and in other contexts.	x	x	x	x
Apply and adapt a variety of appropriate strategies to solve problems.	x	x	x	x
Monitor and reflect on the process of mathematical problem solving.	x	x	x	
Communication				
Organize and consolidate mathematical thinking through communication.	x	x	x	x
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.	x	x	x	

National Mathematics Standards (Grades 3 – 5) – continued

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Connections				
Recognize and apply mathematics in contexts outside mathematics.	x	x	x	x
Representation				
Create and use representation to organize, record, and communicate mathematical ideas.	x	x	x	x
Use representations to model and interpret physical, social, and mathematical phenomena.	x			

International Technology Education Association (ITEA Standards for Technology Literacy, Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Nature of Technology				
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	x	x	x	x
Standard 2: Students will develop an understanding of the core concepts of technology.	x	x	x	x
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	x	x	x	x
Technology and Society				
Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.		x	x	
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.		x	x	
Standard 7: Students will develop an understanding of the influence of technology on history.		x	x	
Design				
Standard 8: Students will develop an understanding of the attributes of design.			x	
Standard 9: Students will develop an understanding of engineering design.			x	
Standard 10: Students will develop an understanding of the role of troubleshooting, research, and development, invention and innovation, and experimentation in problem solving.			x	

International Technology Education Association (ITEA Standards for Technology Literacy, Grades 3 - 5) - continued

Standard	Segment 1	Segment 2	Segment 3	Segment 4
The Designed World				
Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.			x	
Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.	x	x	x	x
Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.			x	

National Technology Standards (ISTE National Educational Technology Standards, Grades 3 - 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Basic Operations and Concepts				
Use Keyboards and other common input and output devices efficiently and effectively.	x	x	x	x
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	x	x	x	x
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and their advantages.			x	
Discuss basic issues related to responsible use of technology and information and describe personal consequences of in appropriate use.			x	
Technology Productivity Tools				
Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.	x	x	x	x
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	x	x	x	x
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	x	x	x	x
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	x	x	x	x
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	x	x	x	x

National Technology Standards (ISTE National Educational Technology Standards, Grades 3 - 5) - continued

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	×	×	×	×
Use technology resources for problem solving, self-directed learning, and extended learning activities.	×	×	×	×
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	×	×	×	×
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	×	×	×	×
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	×	×	×	×
Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.	×	×	×	×

National Geography Standards, Grades 3 - 5

Standard	Segment 1	Segment 2	Segment 3	Segment 4
The World in Spatial Terms				
Standard 1: How to use maps and other graphic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.	×	×	×	×
Places and Regions				
Standard 4: The physical and human characteristics of places	×	×	×	×
Standard 6: People create regions to interpret Earth's complexity	×	×	×	×
The Uses of Geography				
Standard 10: The characteristics, distributions, and complexity of Earth's cultural mosaics	×	×	×	×

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

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.

Careers

astronomer
aerospace worker
mathematician
physicist
planetologist

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

In the Guide

On the Web

Planet to Planet

Create a model of the solar system to learn the order of the planets from the Sun.

Solar System 3-D Puzzle

Create an eight-cube paper puzzle of the solar system

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

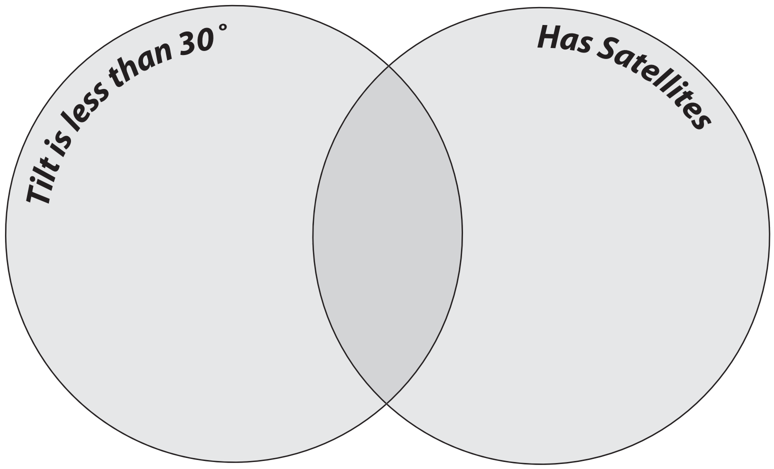
Planet	Distance from the Earth in millions of km (avg)	Distance from the Sun in millions of km	Diameter	Mass Ratio with Earth	Temperature	Gravity	Length of Day	Length of Year	Satellites	Tilt
Mercury	91.7	57.9	4,880 km	0.055	-170˚– 350 ˚ C	0.39	59 days	88 days	0	0˚
Venus	41.4	108.2	12,104 km	0.815	465˚ 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˚

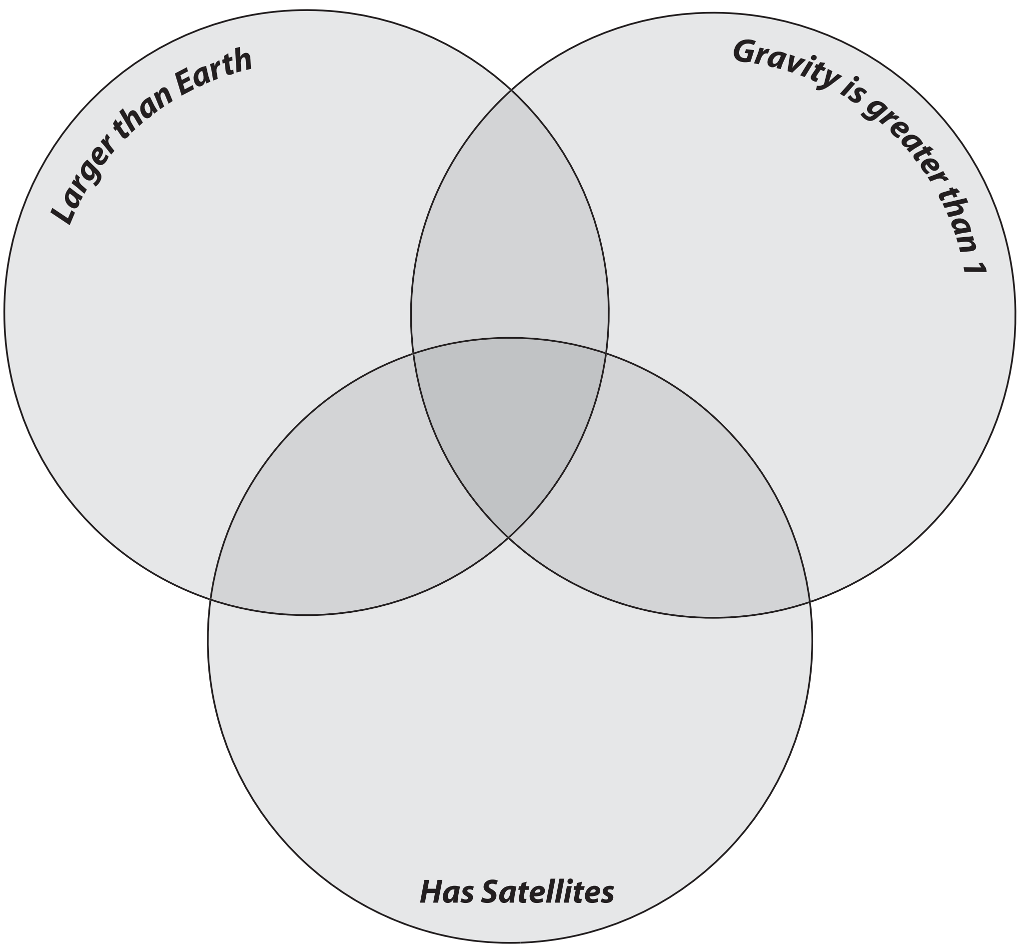
Using the Planetary Data Chart, create bar graphs in your science journal showing
- the number of satellites each planet has.
- the diameter of each planet.
- your choice.

Planning the Planets (concluded)

Venn Diagram

Use the Planetary Data Chart to complete the Venn diagram.





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

Materials

calculator
pencil
science journal

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.

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.

Materials

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

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.

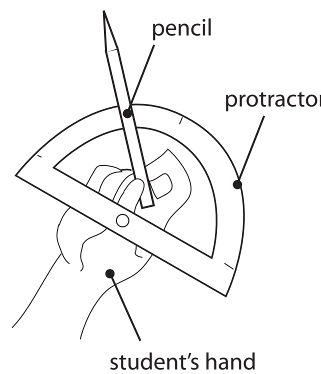


Diagram 1

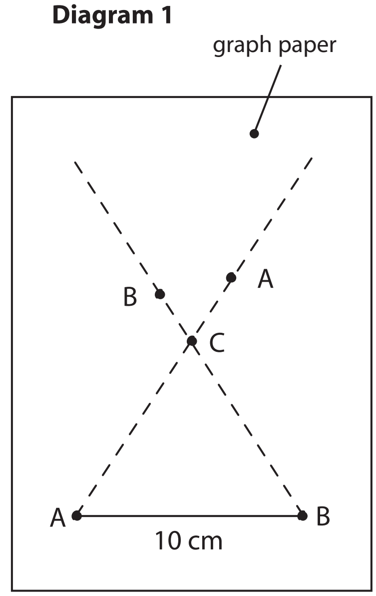


Diagram 2

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.

Answer Key

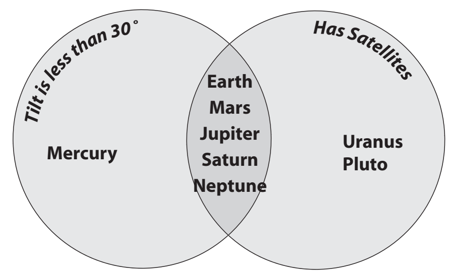
Scaling the Solar System

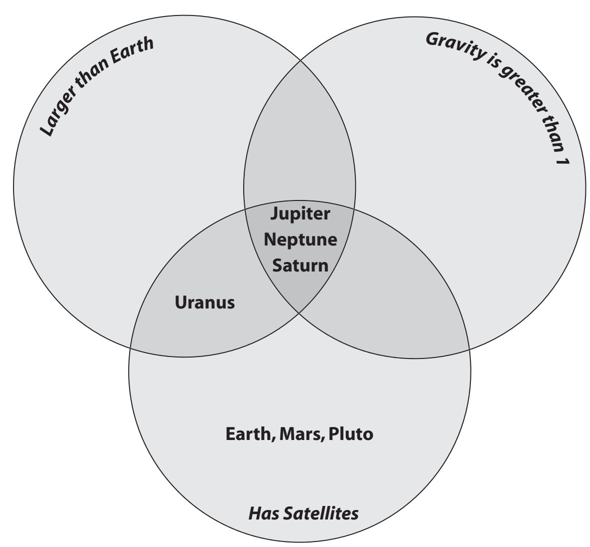
AU Chart

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





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.