TRB 6:4 - Activity 2 - In a Galaxy Far, Far, Far Away

Summary

Students will complete a couple of activities to compare distances between objects in the solar system.

Materials

- meter sticks scaled in both metric and English measurement, one per pair or team of students
- calculators, one per pair or team of students
- transparencies that you make from "Speed of Light " and "The Universe in Numbers " pages (see attachments)
- Hansen Planetarium Solar System Fact Sheet (see below)
- meter stick for each team of students
- local map extending 100 miles from your school. One nice way to get a local map is to use the Internet site http://maps.yahoo.com to create a map with your school at the center. The website offers a variety of zoom magnifications. You can put your school at the center of the map by adjusting the North, South, East, and West directional arrows.
- Utah map
- United States map

Additional Resources:

AIMS. Out of This World.1994.AIMS Education Foundation, P.O. Box 8120.Fresno, CA, 93747. Teacher 's Guide with variety of math and science integrated space activities.

Project Haystack: The Search for Life in the Galaxy. SETI Institute, Teacher Ideas Press, Englewood, CO. 800-237-6124. http://www.setiinst.edu/education/Welcome.html

Simon, Seymour. Galaxies .1988 and the Universe .1998. Both books have information written so students can understand enormous sizes and distances through comparisons. Full color photos.

Background for Teachers

The distances between objects in space are so incredibly vast that they are almost incomprehensible. Measuring these distances with the same measuring units we typically use for distances on Earth requires such huge numbers that they become meaningless. To help solve this dilemma, distances in space are measured using light units, or the time it takes light to travel a particular distance. The most common light unit is a light year: the distance light travels in one year. When distances are put into light units, smaller numbers can be used.

For example, the distance from Earth to the sun is about 93,000,000 miles. That's a pretty big number for the average person to comprehend. If the distance is expressed in light time, then the sun is about 8.33 minutes away from Earth. In other words, light from the sun takes 8.33 minutes to reach Earth. That is a little easier to understand than millions of miles. To get a feel for just how fast light travels, figure that light would be able to travel around Earth about 7.5 times in one second. The speed of light is about 186,000 miles (300,000 km) per second.

Light travel time not only includes the speed at which visible light travels, but also the speed of all energy in the electromagnetic spectrum, including radio waves. This explains why radio transmissions to objects in the solar system have a delay. For example, Mars is about 4.35 light minutes away from Earth. That means it also takes radio signals 4.35 minutes to reach Mars. It would take another 4.35 minutes to return a message. This delay makes it challenging to control robots and space vehicles on Mars with signals from Earth.

Light year is a measurement used to measure distances between stars and galaxies in space. Alpha Centauri is the nearest star to Earth; it is 4.3 light years away. Light years can also be used to describe the size of something. For example, the Milky Way Galaxy is 100,000 light years across.

Intended Learning Outcomes

1-Use science process and thinking skills
3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning

Instructional Procedures

Invitation to Learn:
Show a clip from the movie Star Wars where Han Solo jumps his spaceship The Millennium Falcon, to light speed (about one hour into the film). Discuss: Is this possible? How long would it take even if it were possible? And/or
Discuss with students how things might be measured using different scales. Show students that using some units of measure are not practical.

Would you measure how long the playground is using millimeters?
Would you measure how long a book is by how many letters are in it?
Would you measure how many chocolate chips in a cookie recipe by counting each chocolate chip?
Would you say how old you are by using minutes?

Introduce the idea that distance in the universe is measured in light years. Explain that distances in space are enormous and that light years are a more practical scale than using kilometers or miles.
Activity A
In this activity students will review Astronomical Units or A.U.'s. They will use a meter stick as a comparison for the solar system. Then they will learn about distances in the solar system in light travel time. They will begin by learning how far objects in the solar system are in terms of light travel time. Then they will learn how far several familiar bright stars are from Earth.

Explain the following scale to be used in this activity. This activity assumes that students have had experience with the relative size and distance of objects in the solar system. Ideally it would follow the activity "How Big, How Far." Review with students that an Astronomical Unit or A.U. is the average distance between Earth and the sun. In this activity, a meterstick will represent the radius of the solar system.

Organize students in small groups. Have them use the information from the "Hansen Planetarium Solar System Fact Sheet " (see Materials) or from the chart below to calculate where each planet in the solar system would be on the meter stick. Have students label where each planet is located on a meter stick.

Relative Distance of Planets: Scale =1 A.U.=1 inch								
Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
3/8 inches	3/4 inches	1 inches	1 1/2 inches	5 1/4 inches	9 5/8 inches	19 1/4 inches	30 1/8 inches	39 1/2 inches

Tell students that the star Alpha Centauri is the nearest star to the sun. Ask them to estimate how many miles away the star is. Alpha Centauri is about 26,395,632,000,000 miles away from Earth. Remind them that this is the closest star! Explain that distances beyond the solar system are so enormous that another measuring unit, light years, is needed to measure.

Sirius, the brightest star is over 50,000,000,000,000,miles away. Betelgeuse, the bright red star in Orion 's shoulder is over 3,060,000,000,000,000 (3 quadrillion, 60 trillion) miles away. These huge numbers are incomprehensible.

Explain that light years are the distance that light travels in one year. Show the "Speed of Light " transparency (see Materials). Help students understand that light years are used because the large numbers are so unmanageable.

Describe some distances and time that light travels. For example light could travel the distance around Earth about 7 1/2 times in one second. It takes light about 3 seconds to travel from Earth to the moon and back. Light takes about 8.33 minutes to travel to the sun. Light from the nearest star takes about 4.22 years to reach Earth. Light left Alpha Centauri when the average sixth grader was about 7 or 8 years old. Alpha Centauri is not visible from the northern hemisphere. The nearest star visible in the northern hemisphere is Sirius. It is 7 light years away.

Organize students in small groups. Have them use the information from the "Hansen Planetarium Solar System Fact Sheet " (see Materials) or from the chart on the next page to label the time distances on their meter stick (see Step 2). You may also have students make a graph showing the light travel time. Or you may want them to relate the various times to other times they are familiar with. For example, the time for light to travel to Pluto is about the amount of time students spend in class on a typical school day.

Light Time Travel from the Sun								
Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
3 m 13 s	6 m 1 s	8 m 19 s	12 m 40 s	43 m 16 s	1 h 19 m 28 s	2 h 39 m 50 s	4 h 10 m 25 s	5 h 28 m 53 s

Using the meter stick scale we have developed for the solar system: one light year equals one mile. There are 21 stars that are within 12 light years of our solar system. Seven of them are visible with the unaided eye. Only two of these are among the brightest stars (Sirius and Procyon). The other stars are red dwarfs and only visible with a telescope. Of the 15 brightest stars visible in the Northern Hemisphere, ten of them are within 77 light years. The other five stars are from 197 to 1467 light years away. (See the chart below.)

The Distance of the Fifteen Brightest Stars		
Star Constellation	Actual Distance	Scale Distance 1 light year =1 mile
The Sun to Pluto	5.5 light hours	39.5 inches
Alpha Centauri*(Southern Hemisphere)	4.5 light years	4.5 miles
Sirius Canis Major	8.6 light years	8.6 miles
Procyon Canis Minor	11 light years	11 miles
Altair Aquila	17 light years	17 miles
Vega Bootes	25 light years	25 miles
Fomalhaut Piscis Austrinus	25 light years	25 miles
Pollux Gemini	34 light years	34 miles
Arcturus Bootes	37 light years	37 miles
Capella Auriga	42 light years	42 miles
Aldebaran Taurus	65 light years	65 miles
Regulus Leo	77 light years	77 miles
Antares Scorpius	197 light years	197 miles
Spica Virgo	262 light years	262 miles
Betelgeuse Orion	522 light years	522 miles
Rigel Orion	773 light years	773 miles

Deneb Cygnus	1467 light years	1,467 miles
*Alpha Centauri is not one of the ten brightest stars. It is included for comparison since it is the next nearest star to our solar system		

Make copies of a local map that extends about 12 miles from your school for each student (See Materials). Have each group locate Alpha Centauri, Sirius, and Procyon. Use the Utah map to locate the stars within 77 miles. Use the United States map to locate the remaining stars. In this activity, the stars will not be plotted in their correct relative space from each other; just their distance from Earth. Students should realize that the stars are not in a straight line on the maps, but spread throughout space.

9. Discuss other distances in space. Use "The Universe in Numbers " overhead transparency to show the comparisons.

Activity B

In this activity students will learn how far objects in the solar system and in space are in various modes of transportation they are familiar with. They will gain an understanding of how big these distances really are.

Use an overhead transparency to show how long different travel modes would take to reach various destinations. Six different travel modes and four different locations are given. You may calculate more using the Hansen Planetarium Fact Sheet for the distance to different planets. Students may calculate the distances and times themselves, figuring out how far they could travel at a certain speed in one year. You may have them work in small groups and figure the distance to different planets or stars.

Determine which modes of travel and which destinations you want to use for this activity. Make a blank chart with only the locations and modes of transportation.Make a second chart with the distances scrambled.(See sample chart in the attachments.)

Divide the class into teams of 2 or 3. Give each team a blank chart and a scrambled chart. Have students cut apart the scrambled chart and organize it in the correct order on the blank chart. A sample chart is included in the attachments.

Extensions

To help put the large numbers in perspective, relate it to things the students know. For example, twelve years (the birthday that most 6th graders celebrate) is about 379,000,000 seconds. In the same twelve years, traveling one mile a second (3600 miles per hour --more than six times faster than passenger jets travel), you would only be able to make two round trips to the sun (assuming, of course, that you could travel to the sun).

Hypothetical Travel Time for Modes of Transportation from Earth						
	Walking	Biking	Car	Jet Plane	Space Shuttle	Voyager Probe
Average Speed	7 km/hr	25 km/hr	80 km/hr	800 km/hr	40,000 km/hr	56,000 km/hr
Distance in 1 year	61,320 km	219,000 km	700,800 km	7 million km	350 million km	490 million km
Time to Moon 384,400 km	6.27 years	1.75 years	6 months	20 days	9.6 hours	6.9 hours
Time to Mars	1278	357.7	111.8	11.2	81.6	58.2

78,340,000 km	years	years	years	years	days	days
Time to Pluto 5,766,200,000 km	94,000 years	26,330 years	8228 years	823 years	16.5 years	11.8 years
Time to Alpha Centauri 4.22 light years	652 million years	183 million years	57 million years	5.7 million years	109,000 years	82,000 years
Time to Sirius 8.06 light years	1.33 billion years	373 million years	117 million years	11.7 million years	233,000 years	167,000 years

Some other reference points:

Christopher Columbus discovered America 16,125,933,000 seconds ago (calculated using time from 1492-2003.)

The Declaration of Independence was signed about 7,164,000,000 seconds ago (calculated using time from 1776-2003.)

You may calculate other time using the figure 31,557,600 seconds in a year (60x60x24x365.25.)

Phone home: Have students calculate how long it would take to contact the various planets. Radio waves travel at the same speed as light. See the chart in Extension 3.

Satellite Delay Relay: In this activity two students are "robots " on a distance planet who have to follow directions sent from "astronauts " for constructing a "space station." (This could be a pyramid built of paper cups.) The astronauts are permitted to send only one command at a time. You may want to consider putting in a time delay based on the light travel time to the planet. Students communicating with distant planets would have to send their messages over the course of several days. Explain that radio waves travel at the speed of light. That means that radio waves traveling from Earth to other planets have a time delay as they travel the long distances.

Light Time Travel from Earth								
Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
5 m 6 s	2 m 18 s	0	4 m 21 s	34 m 57 s	1 h 11 m 9 s	2 h 31 m 31 s	4 h 2 m 6 s	5 h 20 m 34 s

Counting Stars: Have students simulate how stars are counted in the sky by using a sampling technique to count the number of symbols on a page of the Want Ads in a newspaper. Cut out 6 squares that are 4 cm square and randomly drop them on a newspaper page. Count the number of symbols in each square and find the average. Calculate how many symbols would be on the entire page.

Assessment Plan

Write a persuasive paragraph concerning whether space travel to distance stars is possible or not.

Calculate how long it would take to travel to a destination in the solar system or a star using different modes of transportation.

Show the Han Solo movie clip again from Star Wars used in “Invitation to Learn.” Have students write whether they think the clip is realistic or not, and why.

Bibliography

This lesson is part of the Sixth Grade Science Teacher Resource Book (TRB3) http://www.usoe.org/curr/science/core/6th/TRB6/. The TRB3 is designed to be your textbook in teaching science curriculum to your students. This book covers all the objectives of each standard and benchmark. If taught efficiently, a student should do well on the End-of-Level (CRT) tests. The TRB3 is designed for teachers who know very little about science, as well as for teachers who have a broad understanding of science.

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