Sample Lesson for Grades 8-9 from

Project Haystack: The Search for Life in the Galaxy

SETI INSTITUTE

The **Life in the Universe Series** was created by
children, teachers, and scientists at the SETI Institute
for grades 3-9, with funding from
the National Science Foundation (NSF)
and the National Aeronautics and Space Administration (NASA).

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Activity 4
Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

Overview

In the previous Activity, students learned how to measure the distance to a star, and gained a feeling for how far away even the closest stars are. But in science fiction, starships cross the galaxy in minutes, and space travel to distant stars seems like a reasonable option to students.

In this Activity, students will consider the enormous amount of **time** that it would take to get to Sirius, a star that of one of the Voyager spacecraft is heading towards, using various modes of transportation- some practical, and some whimsical! This knowledge should lead students to question the practicality of physically going to another star system or attempting interstellar communication with an extraterrestrial intelligence by sending a spaceship there.

What You Need

For Each Team of 2-3 Students:
› Scissors
› Tape or glue
› Student Worksheet: "Bike Years!"

For Each Student:
› Student Worksheet: "Bike Years! Questions"
› Optional Student Worksheet: "Bike Years vs. Light Years"

Getting Ready

1. Copy the Student Worksheets: "Bike Years!", "Bike Years! Questions", & "Bike Years vs. Light Years" if used.

2. Divide the class into teams of 2 - 3 students.

Classroom Action

1. **Discussion**. Tell your students that they will be figuring out how long it would take to get to Sirius, a star in the constellation Canis Major, using six different modes of transportation, including walking or riding a bicycle (if that were possible, which of course it isn't!).

Sirius is the brightest star in the Northern Hemisphere, except for our Sun. Sirius is a relatively "close" star, but its distance from Earth is still 8.6 light years. But what is a "light year"? *Visible light, as well as all of the other types of radiation in the electromagnetic spectrum, travels at the speed of light. The distance that* *light travels in one year is called a light-year, about 6 trillion miles or 9.5 trillion kilometers!* So how long would it take to travel to Sirius? *It depends upon the speed of our vehicle.*

OBVIOUSLY THIS IS IMPOSSIBLE but if we were traveling on a bicycle, how long would it take to get to Sirius then? We could figure that out by considering "Bike Years". So what is a Bike Year? Following the same type of logic as is used to define a "Light Year", it would be the distance that a bicycle rider could ride his/her bike in one year, without ever stopping to eat, sleep, or anything else!

Note that "Light Years" and "Bike Years" are both **distance** measurements, not **time** measurements. However if we know the distance to our destination, we can calculate how long it would take to travel there, if we also know the speed of our vehicle.

It might take a long time to get to Sirius on a bike, but how about on a spacecraft? As you know, the Voyager spacecraft were equipped with phonograph records that contain pictures and sounds depicting our world. One of the Voyager spacecraft is actually headed towards Sirius. If there is an intelligent civilization living on a planet near that star, how many years will it be until Voyager reaches it?

2. **Worksheet**. Divide the class into teams of 2 - 3 students. Hand out the Student Worksheets: "Bike Years!" to each team. Distribute scissors, and glue or tape.

3. **Activity. Have** the students follow the directions given on their Worksheet. They will cut the "Scrambled Data" into blocks which will then be pasted onto their blank data chart. Students will brainstorm together. The only clue that they have to work with is their ability to rank the modes of travel from slowest to fastest! You may be surprised at their choices!

Teacher Information: The speed of the Voyager spacecraft is actually variable. It left Earth with a velocity of about 97,000 km/hr, but it has been slowing down since then. We give 56,000 km/hr as an arbitrary number for comparison. As Voyager approaches and then passes planets, and later suns, the "slingshot effect" will again increase its actual velocity.

Optional: You can have students do all of the calculations on the data chart. If you choose to do the lesson in this way, do not hand out the scrambled data. In addition, you could have the students estimate the speeds for the six modes of travel before giving them the actual accepted values.

4. **Discussion**. After students have completed the Worksheet, engage them in a discussion making sure to cover the correct answers on their Worksheet, discussing anything that they found unusual or surprising.

Some students may believe that a "supersonic jet" travels faster than the space shuttle! Ask them to consider traveling around the Earth in a jet plane. How long would it take? Now ask: how long does the Space Shuttle take to orbit the Earth once? This may help them see the difference. Also have them consider that the Space Shuttle is meant for "local" travel, while the Voyagers were designed to travel much further; they were designed to travel fast!

Ask "Now that you know the speeds of some very fast objects, how fast do you think that light travels"? Write down all reasonable responses on the board, then write down the accepted value of approximately 300,000 km/sec. So what distance is a light year? *About 6 trillion miles or 9.5 trillion kilometers!*

Challenge the students: can they calculate how far away Sirius is in km? Sirius is 8.6 light years away from the Earth. *Sirius is a mind-boggling* 8.17×10^{13} *km from the Earth*. (Ask students to write this number without scientific notation. How would they say this number? If your students are unfamiliar with scientific notation, you may review it with them.)

Considering the time and distance constraints that interstellar travel imposes, what do you think of the possibilities of the interception of the Voyager probe and the message it carries?

5. **Homework**. Hand out the Student Worksheet: "Bike Years! Questions". Have the students finish this in class or assign it as Homework.

Optional: Have students also complete the "Bike Years vs. Light Years" in class or as Homework.

Going Further

ACTIVITY: A SUNNY DAY

Have the students work out how fast light travels to Earth from the sun. It takes sunlight 8.3 minutes to reach Earth. How far away must the sun be? Another way to grasp this is to note that if sunlight could travel in a curved path around the Earth, a ray of light could go 7 times around the equator in one second.

ACTIVITY: THUNDER AND LIGHTNING

You could compare the speed of sound and the speed of light by reminding them of thunder and lightning. Students will be able to see the object that makes the sound (lightning) before they can hear it (thunder). This is a handy way to prove that the light that travels to their eyes covers the distance faster than the sound does. Students may make calculations about how far away the lightning was by how long it takes them to hear the thunder.

Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

BIKE YEARS! PAGE ONE

Name: ____ Date: _____________________

Table 4.1 Blank Bike Years Chart. NOTE: Distance to Sirius = 8.17×10^{13} km

Mode of Travel, Slowest to Fastest	Average Speed	Distance Covered In One Year	Time To Get To Sirius
1.			
2.			
3.			
4.			
5.			
6.			

Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

BIKE YEARS! PAGE TWO

Name: ____ Date: _____________________

SCRAMBLED DATA INSTRUCTIONS:

1. Cut out these scrambled pieces of data.

2. Put all of the modes of travel in the first column of your Worksheet starting with the slowest mode of travel (#1) moving to the fastest mode of travel (#6).

3. Once you are confident that this order is correct, glue, tape or write the data for the next three columns; average speed in km/hr, distance covered in one year in km/yr, and finally the time that it would take to get to Sirius using that particular mode of travel.

Table 4.2 Bike Years Scrambled Data

7 Million km each yr.	233,000 years	Voyager Space Craft	Supersonic Jet Plane
Space Shuttle	490 Million km each yr.	56,000 km/hr	61,320 km each yr.
1.33 Billion Years	Bike	350 Million km each yr.	40,000 km/hr
219,000 km each yr.	25 km/hr	11.7 Million Years	373 Million Years
117 Million Years	7 km/hr	167,000 Years	80 km/hr
Car	800 km/hr	Walking	700,800 km each yr.

Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

BIKE YEARS! QUESTIONS: PAGE ONE

Name: ____ Date: ______________________

1. Would it be practical to travel to Sirius by any of the modes of travel listed on the Bike Years Activity chart? Why or why not?

2. Do you think that it is possible that one of the Voyager spacecraft would ever be intercepted by a civilization around another star, even if such a civilization exists?

3 What travels at the speed of light that is capable of carrying information?

4. What would be the most practical way to get information from Earth to Sirius if we knew that a civilization existed around this star?

5. If perhaps the simulated message that had been received by a radio telescope here on Earth in Activity 1 had come from Sirius, how long ago would it have been sent? Why?

6. SETI scientists are listening to stars that are within 100 light-years of Earth. Why do you think they have chosen this limited distance?

7. Proxima Centauri is the closest star to Earth at a distance of 4.3 light years away. If you stand outside on a clear night and see the light coming from it, how long ago did the light leave that star? Explain your answer.

8. "Star Trek" is a TV show in which a starship goes to other star systems in our Galaxy. Can you think of any practical problems with this idea?

Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

Table 4.3 TEACHER'S KEY FOR "BIKE YEARS!"

Mode of Travel	Speed	Distance Covered	Time to Get to Sirius
1. Walking	7 km/hr	61,320 km each yr.	1.33 Billion years
2. Bike	25 km/hr	219,000 km each yr.	373 Million years
3. Car	80 km/hr	700,800 km each yr.	117 Million years
4. Supersonic Jet Plane	800 km/hr	7 Million km each yr.	11.7 Million years
5. Space Shuttle	40,000 km/hr	350 Million km eachyr.	233,000 years
6. Voyager	56,000 km/hr	490 Million km each yr.	167,000 years

1. More than likely not, since these modes require enormous amounts of time, certainly longer than anyone's lifetime or even multiple generations. Also, obviously bikes, planes, etc. can't travel through space!!

2. STUDENT ANSWERS WILL VARY. Accept all reasonable attempts.

3. Radio, TV and microwaves in the electromagnetic spectrum. In fact all of the radiation in the electromagnetic spectrum can carry information.

4. Send it as radio waves or TV waves since it requires no mass and travels at the fastest speed possible, the speed of light.

5. The message would have been sent from Sirius 8.6 years ago, since Sirius is 8.6 light years away, and radio waves travel at the speed of light.

6. Radio signals would be stronger from stars that are the closest to us. Also, if we receive a message from a star system and we want to respond, it would take the same number of years to get there as it did to come here, so for practical purposes we are listening to star systems that are somewhat closer to us.

7. The light would have left Proxima Centauri 4.3 light years ago since light travels at the speed of light and the star is 4.3 light years away.

8. The crew of the starship Enterprise would be dead long before their starship could get to even the nearest stars if they are traveling at speeds we know are attainable with present day or even foreseeable technology!

Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

BIKE YEARS VS. LIGHT YEARS

Name: ____ Date: ______________________

PART I.

Figure out how far a bicycle can travel in one year, assuming a rate of speed of 25 km per hour, with the rider never stopping to eat, drink or sleep. This computed distance will equal **ONE BIKE YEAR, or the distance that a bicycle can travel in one year.**

Bicycle travels at a rate of speed = 25 km/hr

X _____ hours per day = ________________ km per day

X _____ days per year = ________________ km per year

THIS IS THE DISTANCE A BIKE GOES IN ONE YEAR, OR ONE "BIKE YEAR".

PART II.

Figure out how far a ray of light can travel in one year. This computed distance will be considered **ONE LIGHT YEAR, or the distance that light can travel in one year.**

Light travels at a rate of speed = 300,000 km per second

X ____ seconds per minute = ___________________ km per minute

X _____ minutes per hour = ___________________ km per hour

X _____ hours per day = ______________________ km per day

X _____ days per year = ________________________ km per year

THIS IS THE DISTANCE LIGHT TRAVELS IN ONE YEAR, OR **ONE LIGHT YEAR**

Calculating Stellar Travel Times.

How Long Would It Take to Travel to the Stars?

TEACHER'S KEY FOR "BIKE YEARS VS LIGHT YEARS"

PART I.

Figure out how far a bicycle can travel in one year, assuming a rate of speed of 25 km per hour, with the rider never stopping to eat, drink or sleep. This computed distance will equal **ONE BIKE YEAR, or the distance that a bicycle can travel in one year.**

Bicycle travels at a rate of speed = 25 km/hr

X __24___ hours per day = 600 km per day

X __365___ days per year = 2.19×10^5 km per year

THIS IS THE DISTANCE A BIKE GOES IN ONE YEAR, OR ONE "BIKE YEAR".

PART II.

Figure out how far a ray of light can travel in one year. This computed distance will be considered **ONE LIGHT YEAR, or the distance that light can travel in one year.**

Light travels at a rate of speed = 300,000 km per second

X __60__ seconds per minute = 1.80×10^7 km per minute

X __60__ minutes per hour = 1.08×10^9 km per hour

X __24___ hours per day = 2.59×10^{10} km per day

X __365___ days per year = 9.46×10^{12} km per year

THIS IS THE DISTANCE LIGHT TRAVELS IN ONE YEAR, OR **ONE LIGHT YEAR**