# Scale Model of Our Nearest Stars

## Summary

Students calculate the relative distance of objects in our universe and build a scale model using a length of string.

## Time Frame

1 class periods of 45 minutes each

## Group Size

Large Groups

## Materials

- Calculators
- Ball of string 41 meters long (If that length is not attainable, string 17 meters long will also work.)
- Universal Scale Worksheet (1 per student) (included in lesson)
- Universal Scale Worksheet: Teacher Answer Sheet

## Background for Teachers

There is so much space even within galaxies that normal distance measurements are worthless. Scientists use a distance measurement in space that is expressed as the distance light will travel in the course of a year a light year. Light travels at a speed of about 186,000 miles per second. That means that light can travel 7.5 times around the entire world in just one second. In a year's time, light can travel six trillion miles (6,000,000,000,000). It takes over four years for the light from the nearest star to reach the Earth.

Now that we have the light year scale to use, we can compare that to more understandable speeds and reference those speeds as the time needed to arrive at a neighboring planet, star, or galaxy.

You know what it feels like in an automobile traveling 60 miles per hour. It is not unusual for a jet to travel 10 times that speed 600 miles per hour. Therefore, a jet can go 10 miles in one minute or 1/6 mile in one second. Now let's compare that speedy jet to a rocket. A kind of average rocket speed is about six miles per second. Next, if we compare the rocket speed to the speed of light, we find that light travels 31 thousand times faster! Mind boggling isn't it? Keeping in mind that the car is 10 times slower than the jet, let's take a look at projected travel times if we could fly an airplane into space, ride a rocket, or ride a sunbeam. See the **Travel Times in the Universe** page attached below for a chart comparing the different travel times.

## Intended Learning Outcomes

- Use mathematical reasoning to communicate information.
- Record data accurately.
- Construct a model.

## Instructional Procedures

The idea of this lesson is to give students a sense of the vast distances and emptiness of space. Read the teacher background information. Explain the concept of light year to the students. You may want to use the **Travel Times in the Universe** page attached in the Background for Teachers portion to assist your instruction. Emphasize that a light year is how far light will travel in one year it is a measure of distance not time.

For this model,use the scale of one meter equal to one light year.

To determine the scale distances for the planets, the students will need to know the scale distance for: a light day (how far light travels in a day), a light hour (how far light travels in an hour) and a light minute (how far light travels in a minute). Use the following steps to determine these scale distances. Students should record their answers on the **Universe Scale Worksheet** attached below. Use the **Universe Scale Worksheet Answers** for your own reference.

> Since one meter equals one light year, one meter equals 365 light days. To find the scale distance for one light day, take one meter and divide it by 365 to get the scale distance for a light day. 1 / 365 = 0.00274. So, one light day is 0.00274 meters, or 0.003 meters (rounded), or 0.3 centimeters, or about 3 millimeters.
>
> Since one day equals 24 hours, one light hour equals 0.00274 divided by 24. 0.00274 / 24 = 0.000114. So, one light hour equals 0 .000114 meters, or about 0.0001 meters (rounded), or about 0.1 millimeters.
>
> Since one hour equals 60 minutes, one light minute equals 0.000114 divided by 60. (0.000114 / 60 = 0.0000019) So, one light minute equals 0.0000019 meters, or about 0.000002 meters (rounded), or about 0.002 millimeters

Now have the students calculate the scale distances to the planets and stars. For example, since Earth is 8.5 light minutes from the sun, its scaled distance would be 8.5 times 0.002 millimeters, which is 0.017 millimeters, or about 0.02 millimeters. Pluto is five light hours and 25 light minutes away from the sun. Pluto's scaled distance would be 5 times 0.1 millimeters (5 x 0.1 = 0.5 millimeters) plus 25 times 0.002 millimeters (25 x 0.002 = 0.05 millimeters), which is 0.55 millimeters. This is half of the smallest mark on a meter stick.

After the students have done their calculations, have them build a scale model. They can make marks on the length of string and lay it out in a hallway or out on the playground. Note: The students will not be able to fit in all of the stars on their scale because of the large distances involved, and it will also be difficult for them to show the small sizes (the planets).

Return again to the **Travel Times in the Universe** page attached in the Background for Teachers section. This table is much more than a chart of travel time; it represents a glimpse into the past. When you look into the night sky, you are looking into the history of the universe. The sunlight that shines on us is 8.5 minutes old when it reaches Earth. Sunlight reflected from Pluto takes 5.5 hours to reach the astronomer's telescope. When the light of Sirius hits your eye, those photons have been traveling for over eight years through space. This means you are seeing that star not as it is tonight by as it was over eight years ago. And most of the stars we see in the sky are hundreds or thousands of light years away. The Andromeda galaxy, at a mere 2.2 million light years, is truly a next-door neighbor. All of the other galaxies are millions upon millions of light years distant. And that's how big the universe is!

Conclude by having students write in their science journal. Their writing should be reflective in nature and should include what they have learned about the speed of light as well as the size of the universe.

## Extensions

Is it really possible to explore the universe?

Is it really possible to explore the Milky Way Galaxy?

Is it really possible to explore just our own solar system?

Have students identify challenges in traveling the immense distances between the planets in our solar system.

Propose that NASA would like to send a manned space shuttle to Pluto. Have students identify the time necessary to travel the distance. Once they understand how long the journey will be, have them consider ways to make the trip possible (food, water, waste, etc.)

## Assessment Plan

Collect, read, and assess student science journals.
Look for new understandings concerning the vastness of space.
Identify any misconceptions concerning the speed of light.
Evaluate for clarity in expressing scientific concepts.

## Authors

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