

SE 8.13 B: Light Years
Concept Page for Teachers

Objective: (8.13 B) Explain the use of light years to describe distances in the universe.

Scientific question: How far is a light year?

Background information: In this lab we are going to measure distance by measuring time. Light travels very fast. It is the fastest thing (that we currently know of) in the universe. Light travels slightly less than 300,000,000 meters in one second in a vacuum. For those tied into the customary or English measurement system, that is 186,411 miles in one second. It only takes light 1.28 seconds to travel from the Moon to the Earth. Since there are 60 seconds in a minute and 60 minutes in an hour and 24 hours in a day and 365.25 days in a year, then there are $60 \times 60 \times 24 \times 365.25 = 31,557,600$ seconds in a year. Light travels 186,411 miles in a second, which means that light travels:

$$31,557,600 * 186,411 = 5,882,683,773,600 \text{ miles in one year.}$$

This tells us that a **light year** is approximately 5,880,000,000,000 miles

The closest star system (Proxima Centauri) is 4.2 light years from our solar system. You can see that the galaxy is a big place. This is the reason that astronomers use light years to measure distances. It would be awkward to say that Proxima Centauri is 24,696,000,000,000 miles from our solar system.

Our sun is 27,000 light years from the center of our galaxy. It would be difficult to express this in kilometers or miles.

Because light is so very fast, we will be focusing on very small distances using even smaller units of time. A nanosecond is one billionth of a second. That is 0.000,000,001 seconds. We know that light travels 300,000,000 meters / second, thus it takes one nanosecond for light to travel 0.3 meters. This is very close to the customary unit of one foot.

This lab will have students determine how long it takes for light to travel distances that you can measure.

Points to clarify with students: A light year is a very large distance and a light nanosecond is a very small distance. Neither of them measure time.

Vocabulary: light year, nanosecond, light-nanosecond

light Year – the **distance** that light travels in a year

nanosecond – one billionth of a second.

light-nanosecond - light travels 0.3 meters(30 centimeters) in one nanosecond so a light-nanosecond is 30 centimeters.



Materials list: A meter stick and a flashlight each for 5 or 6 groups of students.

Classroom setup: Divide the students into 5 or 6 groups. Give each group a flashlight and a meter stick. You may even want to allow one group of students out into the hall to measure there (one group at a time under your supervision), or utilize a gym or other large area.

Classroom introduction for students: How many of you have heard the expression “a light year”? (*various responses*) Raise your hands if you think this is a measure of time. (*various responses*) Raise your hand if you think that a light year is a measure of distance? (*various responses*) Today we are going to be discussing very long distances and very short periods of time.

A light year is a measure of distance. It is the distance that light travels in one year. Light travels very fast. [Review with students the background information section.]

Since light is so very fast, we will be discussing very small distances with even smaller times. **A nanosecond is one billionth of a second.** That is 0.000,000,001 seconds. Light travels 300,000,000 meters / second, so it takes one nanosecond for light to travel 0.3 meters. This is very close to the customary unit of one foot.

Today we will be measuring distance in light-nanoseconds. That is how many nanoseconds it takes light to travel between objects that we can measure. **A light-nanosecond is 30 centimeters.**

Procedure: Place a list of distances that the students will measure in your room and in the hallway on your overhead projector or on your whiteboard. This list should have at least 20 distances in it. Include the width, length and height of your room. Include the diagonal distance across your room, and the distance from your desk to two of your walls. You might want to take the students to your gym or playground for this exercise, to gather more distances.

For each distance measured have the students place the flashlight (turned on) at the location where they will measure from. The flashlight allows the students to visually see that they are measuring the distance that the light travels. Have the students measure out to the other side of the distance using their meter sticks. They need to be measuring these distances in 30 centimeter increments. So for example if your room is 12 meters wide, your students will measure 12m / 0.3m or 40 light-nanoseconds.

Questions to ask while you are processing out the lab:

How many light-nanoseconds wide was our classroom?

Why did we measure our distances in light-nanoseconds instead of in light years? (*because a light year is trillions of miles long*)

Is a light-nanosecond a time or a distance? (*distance*)

Is a light year a time or a distance? (*distance*)

Is a light year a small or large distance? (*very large*)

Name _____

Date _____

Light Years

Objective: (8.13 B) The student knows characteristics of the universe. The student is expected to explain the use of light years to describe distances in the universe.

Scientific question: How far is a light year?

Equipment & materials: a flashlight and meter stick for each group

Procedure: Place your flashlight at locations that your teacher will determine, measure the required distances in light-nanoseconds.

Location #	Location Name	Light-nanoseconds	Location #	Location Name	Light-nanoseconds
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

Why did we measure our distances in light-nanoseconds instead of in light years?

Is a light-nanosecond a time or a distance? _____

Is a light year a time or a distance? _____

Is a light year a small or large distance? _____

Observations: _____

Conclusion: _____

The Student Expectation we studied in this lab was _____
