Environmental Science Institute
UNIVERSITY OF TEXAS AT AUSTIN

How Far is a Light Year?

Subject: IPC

Grade Level: 9^{th} – 11^{th}

Rational or Purpose: This lesson aims to teach students to compare interstellar bodies in an appropriate scale. It will introduce and strengthen students' concept on unit conversion and dimension analysis.

Materials:

Calculator
Post-assessment quiz

Lesson Duration: 40 minutes

TEKS Objectives:

§112.42. Integrated Physics and Chemistry
(c) (2 a-d) (4a)

Background Information:
Exploration of the Universe has been a dream for many people, especially for youngsters. We appreciate the sky at night when numerous of stars decorate the plain dark sky. Due to the limitation of current technology and human physical capabilities, we have not yet resolved all the mysteries of the Universe. One of the major problems that we encounter is that the amount of time necessary to travel from the Earth to other planets is so lengthy that the journey would outlast our normal lifespan.

For such long distances, it would be too cumbersome to use meters or kilometers to describe the length. Therefore, scientists have come up with another notation, a light year, to represent these great distances. A light year is the distance that light will travel in one year. Even if we could design a machine that could travel twice as fast as sound, it would take at least 455,000 years for us to travel one single light year. Unless we can overcome the speed limitation, we may not be able to physically visit other interstellar bodies that are distant from us.

Activity
Students will be asked to find some constants (e.g. distance between the Earth and the Moon) prior to class. Then, in groups, students will carry out some calculations using the constants, unit conversion, and dimension analysis to answer conclusion questions. After students get a sense of how far is a light year, they will discuss what we must overcome in order to travel such a great distance.

Procedure

1. Students are asked to find the following information from reliable resources (such as encyclopedia, online encyclopedia)

    a. Speed of light (in units of meters per second)
    b. Circumference of the Earth
    c. Distance between the Sun and the Earth
    d. Distance between the Earth and the Moon
    e. Distance between the Earth and the Mars

2. Teacher will review the concepts of unit conversion and scientific notation (if previously taught) or introduce these concepts. (Suggestion: If most students are not familiar with the concepts, it is *strongly* recommended that teacher spends *at least* one class period to let students become familiar with the concept of unit conversion and scientific notation before teaching this lesson.)

3. Group students (2 or 3 students per group) to calculate the followings:

    What is the distance that light will travel in:
    a. 1 second?
    b. 1 minute?
    c. 5 minutes?
    d. 1 hour?
    e. 12 hours?
    f. 1 day?
    g. 1 month?
    h. 1 year?

    Note: Teachers should adjust the progress of this section according to students' understand to avoid confusion. The goal of the above calculations is to help students become familiar with the conversions and understand the concept progressively.

4. Introduction to dimension analysis. Ask students for the units of the above calculations. Students will learn how to use the unit to check their answer or predict what the calculation is about. For example, light travels 299,792,458 m / s. In this case, the calculation is about distance.

5. On the board, write down the distance that light travels in a year, which is 1.58 x 10^{14}m. Ask the students to put away their calculations and focus on the value on the blackboard. Discuss with the class what this value represents. Remind students that they will need to remember this value after the class period has ended.

6. Introduce the word “light year” to students. Ask the students to guess what a light year describes. After a brief discussion, teacher will give the correct definition of a light year.

7. In groups, teacher will ask the students to convert the values in step 1 (excluding the speed of light) to light year. Ask students to describe what the values represent.

8. (Optional) Briefly mention that, according to Einstein, no other object can surpass the speed of light except light itself.

9. Ask students to consider and discuss: “If we are able to travel with a speed close to the speed of light, what difficulties must we overcome? The difficulties include:

    a. How does such speed affect our blood circulation?
    b. How can we design a device that allows us to travel with such great speed?
    c. How would the traveling device sustain from wear and impacts from interstellar objects during the journey?

10. Ask students to visit the following website:
    http://www.nasa.gov/centers/glenn/research/warp/warp.html
    Encourage students to read the contents. Focus on the section “Some Emerging Possibilities.” It will appear on the extra credit section of the quiz.

Name: _____ Date: _____

Class Section: _____

How Far is a Light Year?

Quiz

What is the speed of light (in meters per second)?

_____

In your own words, define a light year?

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Using the value of the speed of light, calculate the distance light travels in one year. Be sure to use scientific notation in your answer.

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Given that the distance between planet Neptune and the Earth is 4305.9×10^9 m. If we design an unmanned traveling machine that can travel at 60% of the speed of light, how long does it take to travel from the Earth to Neptune? (Ignore the air resistance due to Earth's atmosphere.)

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Extra Credit: Given our current limitations in interstellar travel, list and describe (maximum of 2) ways that humans could possibly travel to distant planets.