Chapter 18: Drake's Equation

Student Worksheet

Objective:

Use Drake's Equation to predict the probability of life in the universe.

Engage:

The Milky Way most likely has between 100 billion and 400 billion stars. Astronomers are finding that about half the stars they see have planetary systems. Do you think there is other life in our galaxy? Do you think there are other intelligent civilizations in our galaxy with the technology to communicate with other worlds? If so, how many of these civilizations do you think exist?

Introduction:

In this activity you will use an equation that estimates the number of intelligent, communicating civilizations that exist in a population of stars. Frank Drake is an American astronomer who has done a great deal of work in the Search for Extraterrestrial Intelligence (SETI).

The Drake Equation is:

$$N = R^\star \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

- **N** represents the number of intelligent, communicating civilizations in your stellar population. Solve for this number.

    You will estimate values for the following terms:

- **R⋆** represents the rate of star formation per year in your stellar population
- **F_p** represents the percentage of stars that form planets
- **n_e** represents the number of planets in a habitable zone around the star (not too close, not too far)
- **f_l** represents the percentage of the planets in the habitable zone on which life actually occurs
- **f_i** represents the percentage of the planets where intelligence develops

- **f_c** represents the percentage of the planets that produce interstellar communication
- **L** represents the lifetime of a communicating planet in years.

Your Task:

Choose values to input into the Drake Equation. Compare your result with Frank Drake's result and with the results of the rest of your class.
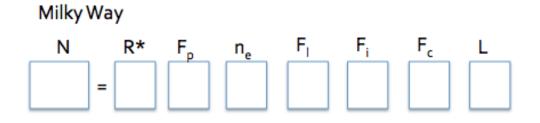
Procedure:

1. To get a sense of some of these common values take a look at Frank Drake's estimations for the Milky Way galaxy.

   - **R^*** = 5
   - **F_p** = 50%
   - **n_e** = 2
   - **f_l** = 100%
   - **f_i** = 100%
   - **f_c** = 20%
   - **L** = 10,000
     - When solving the Drake Equation, percentages are plugged in as decimals.
     - His values are for the Milky Way galaxy. So if you choose a stellar population larger or smaller than the Milky Way you would need to adjust R^*, the rate of star formation.

2. Choose a stellar population for your Drake Equation calculation—e.g., the Milky Way, the Andromeda galaxy, the Small Magellenic Cloud, the Local Group, the entire universe…

3. Calculate your version of the Drake Equation. Show your values below.

Stellar population

N		R*	F_p	n_e	F_l	F_i	F_c	L
	=							

Conclusion:

1. What is Frank Drake's number of intelligent communicating civilizations in the Milky Way?

2. If you solved the Drake Equation for the Milky Way, how would your values compare to Drake's? What parameters were most different? Why? Show your values below.

Milky Way

N		$R*$	F_p	n_e	F_l	F_i	F_c	L
☐	=	☐	☐	☐	☐	☐	☐	☐

3. If you were to choose the universe as your stellar population, why would simply multiplying the rate of star formation in the Milky Way by the number of galaxies in the universe not be quite right?

4. The Drake Equation talks specifically about planets being the places where life forms. In our solar system Mars, Europa, and Enceladus are talked about as some of the most likely places for life. Enceladus and Europa are moons. How would your results change if moons were accounted for in your calculation?

Extend:

- Make an analogous formula for something else. For example, physicist Enrico Fermi used to give his students warm-up questions where they would estimate strange numbers, like the number of piano tuners in Chicago, the number of pizzas ordered in California each year, how many hairs on a human head, etc. Choose a number, which can be reached only through estimation, and design a formula to estimate it.
- The SETI organization is running a project that uses personal computers from around the world to help with its search. Look for SETI at Home to join the effort.