

# Seagar Equation vs. Drake Equation

**Grade:** 9-12

**Subject Integrated:** Science, Mathematics

**Rationale:**

In this lesson, students will compare the Seagar and Drake Equations through scientific background, as well as mathematical calculations.

**Objectives:**

Students will be able to distinguish between the Seagar and Drake Equations, through scientific evidence, mathematical calculations, and literacy.

**Materials:**

- Handouts (links below)
- Computers
- Calculators
- Sticky Notes

**Learning Activities:**

a) Instructional Materials and Resources

- <http://www.centauri-dreams.org/?p=28976> printed as a handout
- <http://www.seti.org/drakeequation> printed as a handout

b) Procedure

- Students will receive both handouts and read them.
- Teacher will split whiteboard into similarities and differences. Students can work independently or in small groups to initially brainstorm their ideas about similarities and differences. Give them plenty of processing time--this sort of comparison of complex mathematical equations may be novel and uncomfortable.
- After students have had some time to get used to the task, the teacher will distribute sticky notes for students to record similarities and differences of each of the equations
- After reading and highlighting these similarities and differences students will write out what they have found and post them under proper header on the whiteboard.
- Teacher will ask students about what they discovered about the two equations.
- Teacher will read aloud sticky notes under each header on board.

- Teacher will probe class to answer why we use these equations and how they are similar and different.
- Teacher will go through each variable found in the equations and write them down on the whiteboard. At this point, the class will move away from analyzing how the equations work and are similar/different. They will now begin thinking about what numbers/estimates might be reasonably used for each of the variables in the equations.
- Students will use computers to research further about both Seagar and Drake equations, especially where the class seems divided or unclear about what reasonable values of variables might be.
- Students will determine a plausible value for each of the estimates, and they must have a reliable source and/or sound reasoning they can articulate for their values/estimates.
- Students will hand in a paper explaining narratively (in plain language) what both the Seagar and Drake equations are, the formulae, and the numerical values they arrived upon, accompanied by sound reasons.

#### c) Instructional Groups

- Lesson will be taught to the class as a whole with plenty of opportunity for students to scaffold one another in small or large groups as needed.

#### d) Discussion

- What is the Drake Equation?
- What is the Seagar Equation?
- What is similar between the two?
- What is different?
- What do these equations determine?

#### e) Assessment

- Formative assessment will be critical as the students work their way through the equations and compare them. This will be a very difficult task for some students, but it is functional learning, so the time is well spent as individuals learn more deeply about how equations work.
- Summative assessment will be used in assessing final papers.
- Teacher will guide students to useful resources and/or plausible reasoning that helps them arrive at their own answers if they are having trouble.
- Teacher will take notes on students with trouble with the skills for further assistance.
- The teacher will assess the students' based on their completion of the assignment and participation in the discussion.

**Closure:**

## a) Ending the Lesson

- Students will hand in equations and explanations

## b) Evaluating and Reflection of the Lesson

- Formative assessment will be critical. If large sections of the class have difficulty interpreting and comparing the equations, it may signal a shallow understanding of equations. It would be worthwhile to extend this lesson over several class periods to provide deeper learning opportunities as needed. At times, breaking into small groups in which at least one student has deeper understanding to scaffold the others may be useful, but all students should be able to articulate their own understandings before moving away from this lesson.
- Evaluation of lesson will be done by thorough summative assessment.
- Teacher will observe to make sure each student understands the concept introduced in the lesson.
- Teacher will make sure all requirements and guidelines are met by giving collaboration opportunities and/or one-on-one problem-solving opportunities to students who struggle with the skills.
- Teacher will self-critique on what worked well and what did not work well in the lesson.

**Standards:**

- NGSS: HS-LS2-1. (supportive fit) Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- CCSS.MATH.CONTENT.HSF.LE.A.1 (strong fit) Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Teacher References:**

- Dr. Nicolle Zellner (nzellner@albion.edu)
- Dr. Melissa Mercer-Tachick (melissa@museconsulting.info)
- <http://www.centauri-dreams.org/?p=28976>: This is an article about the Seagar equation.
- <http://www.astrobio.net/interview/the-drake-equation-revisited-an-interview-with-sara-seager/>: This is an article about the Seagar equation in connection to the Drake equation.
- <http://io9.gizmodo.com/what-a-brand-new-equation-reveals-about-our-odds-of-fin-531575395>: This is an article about the Seagar equation.

- <http://www.seti.org/drakeequation>: This is an article about the Drake equation, including the formula.
- <http://www.space.com/25219-drake-equation.html>: This is an article about the Drake equation.
- <http://www.as.utexas.edu/cgi-bin/drake.pl>: This is a website with a Drake equation calculator.