

Should We Answer?

SETI, the Fermi Paradox, and the Risk of Saying Hello

Name _____ Class _____ Date _____

PART 1: THE GREAT SILENCE



The 64-meter Parkes radio telescope in Australia, one of the instruments used to search for signals from other civilizations

The universe is approximately 13.8 billion years old. Estimates of the number of galaxies in the observable universe range from several hundred billion to as many as two trillion. Our own Milky Way alone holds between 100 and 400 billion stars, most of which are now thought to have planets. Given these staggering numbers, the Italian physicist Enrico Fermi is said to have asked a simple question over lunch at Los Alamos in 1950: "Where is everybody?" If intelligent life should be common in a universe this vast and this old, why have we found no evidence of it? This question became known as the Fermi Paradox.

The silence is deafening. Since 1960, the Search for Extraterrestrial Intelligence (SETI) has used radio telescopes to scan the sky for artificial signals, meaning patterns that could not be produced by natural phenomena. In more than six decades of listening, we have confirmed nothing. The most famous candidate is the Wow! Signal of August 15, 1977: a powerful, narrowband radio signal picked up by Ohio State University's Big Ear telescope. Astronomer Jerry Ehman circled it on the printout and wrote "Wow!" in the margin. The signal lasted 72 seconds, closely matched what scientists expected an extraterrestrial transmission to look like, and has never been detected again.

Even the Wow! Signal may have a natural explanation. In 2024, a team led by the astronomer Abel Mendez proposed that it came from a cloud of cold hydrogen gas that was suddenly made to shine by a

burst of radiation. The source could have been a magnetar, an extremely magnetic collapsed star. The idea has not been confirmed, but it is a reminder of how SETI usually goes. In 2020, a promising signal recorded by the Parkes telescope, apparently coming from the direction of our nearest neighboring star, caused real excitement. A year later, researchers showed that it was interference from human technology.

PART 2: ACTIVE SETI, SHOULD WE SHOUT?



The Voyager Golden Record and its engraved cover, which carries instructions for playing it. A copy is aboard each Voyager spacecraft.

Photos: NASA/JPL (public domain)

Listening is one thing, but some scientists want to go further and transmit messages into space, actively announcing humanity's existence. This is called Active SETI, or METI (Messaging Extraterrestrial Intelligence). In 1974, the Arecibo Message was beamed from a giant radio telescope in Puerto Rico toward a star cluster roughly 25,000 light-years away. It contained basic information about our solar system, the structure of DNA, and a stick figure of a human being. The telescope that sent it no longer exists; it collapsed in December 2020. NASA's two Voyager spacecraft, launched in 1977, each carry a Golden Record: a gold-plated disc containing sounds, music and images from Earth, including greetings in 55 languages. Voyager 1 is now more than 25 billion kilometers away, reaching a distance of one light-day from Earth in November 2026.

Not everyone thinks broadcasting is wise. In a 2010 documentary, the physicist Stephen Hawking warned: "If aliens visit us, the outcome would be much as when Columbus landed in America, which didn't turn out well for the Native Americans." The scientist and author Jared Diamond went further in his book *The Third Chimpanzee*, describing the Arecibo broadcast as "suicidal folly" and calling astronomers who planned to send more signals "naive, even dangerous." His reasoning was historical: when human explorers met people with less advanced technology, the result was usually conquest and disease. He saw no reason to assume that visitors from another world would behave better than we did.

Critics of Active SETI argue that we are lighting a fire in the dark forest and attracting the attention of unknown beings whose intentions we cannot predict. If the Dark Forest Theory from Lesson 1 is correct, shouting into the dark could be the last mistake a civilization ever makes. Supporters reply that hiding is no longer possible, since Earth has been leaking radio and television signals for about a century. Any civilization advanced enough to threaten us could probably detect signs of life in our atmosphere anyway.

PART 3: THE DRAKE EQUATION

In 1961, the astronomer Frank Drake wrote down a formula to estimate the number of detectable civilizations in our galaxy. The Drake Equation multiplies several factors together: the rate at which stars form, the fraction of stars with planets, the number of those planets that could support life, the fraction where life actually develops, the fraction where it becomes intelligent, the fraction that develops detectable technology, and the length of time such civilizations go on broadcasting signals.

The Drake Equation

$$N = R^* \times fp \times ne \times fl \times fi \times fc \times L$$

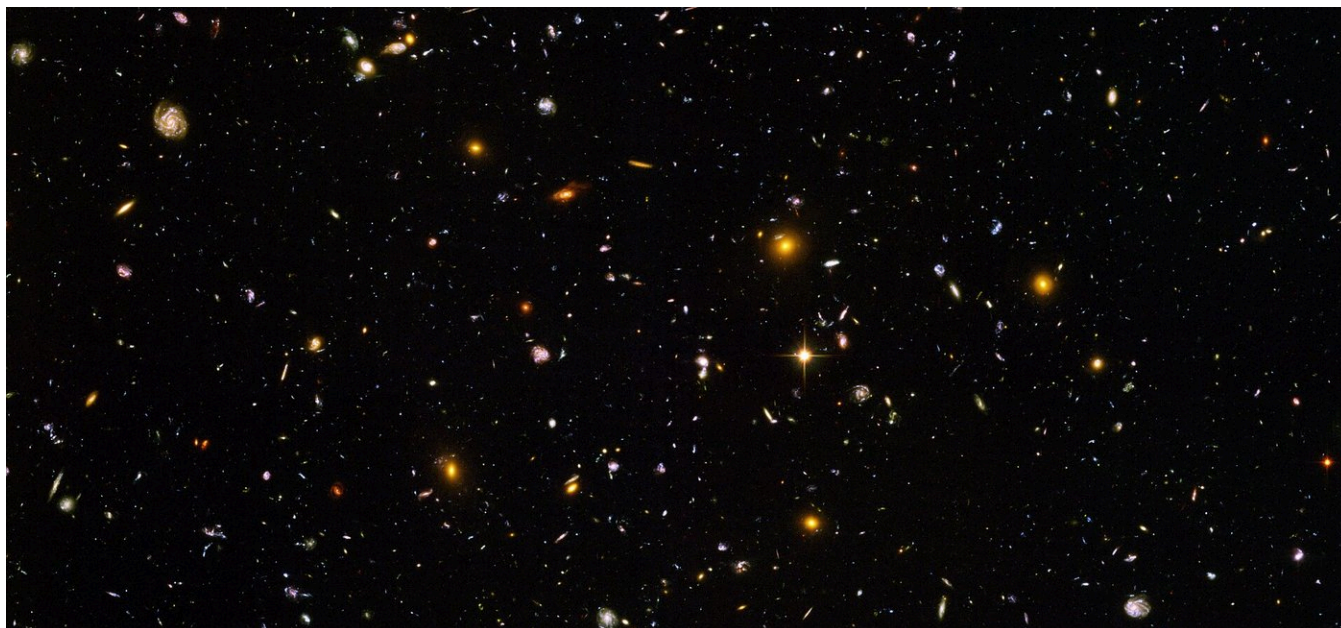
N = number of detectable civilizations; R^* = rate of star formation; fp = fraction of stars with planets; ne = habitable planets per star system; fl = fraction where life develops; fi = fraction where intelligence develops; fc = fraction that communicates; L = how long such civilizations last.

The problem is that most of these values are unknown. When Drake wrote the equation, nobody had ever seen a planet outside our solar system. Today astronomers have confirmed thousands, so the first few terms are no longer guesses, although the later terms still are. Depending on your assumptions, the equation can produce anything from less than one (we are alone) to millions of civilizations.

The most uncertain variable is the last one: how long civilizations survive. If most of them destroy themselves through war, environmental collapse or reckless technology within a few centuries of inventing radio, the galaxy could be full of dead worlds. The silence of the cosmos might not mean that life is rare; it might mean that intelligent life does not last.

PART 4: FERMI PARADOX SOLUTIONS

Scientists have proposed dozens of solutions to the Fermi Paradox. The Great Filter, an idea put forward by the economist Robin Hanson in the 1990s, suggests that there is some barrier, some step between dead matter and a galaxy-spanning civilization, that is extremely difficult to pass. If the filter is behind us (the development of complex cells, for example), then we are lucky survivors and the universe is mostly empty. If the filter is ahead of us (perhaps powerful technology tends to lead to self-destruction), then our future is dark. This is why some thinkers say that finding simple life on Mars would be bad news: it would suggest that the early steps are easy, and that the hard part is still to come.



The Hubble Ultra Deep Field. Almost every point of light in this tiny patch of sky is an entire galaxy.

Image: NASA and the European Space Agency (public domain)

Other solutions are equally unsettling. The Zoo Hypothesis, proposed by the astronomer John Ball in 1973, suggests that advanced aliens know we exist but deliberately avoid contact, like wildlife researchers observing animals without interfering. The Planetarium Hypothesis goes further: perhaps the universe we observe is a kind of simulation, built by an advanced civilization to look empty.

Then there is the simplest, most humbling answer of all: perhaps we are looking in the wrong place, at the wrong time, with the wrong technology. The universe is vast, and we have been listening for less than seventy years. In cosmic terms, that is less than a blink.

KEY VOCABULARY

Term	Meaning	Term	Meaning
<i>Fermi Paradox</i>	the contradiction between the high probability of alien life and the lack of any evidence for it	<i>extraterrestrial</i>	originating from outside Earth
<i>SETI</i>	the Search for Extraterrestrial Intelligence; the scientific effort to detect alien signals	<i>transmit</i>	to send a signal or message outward
<i>Active SETI / METI</i>	deliberately sending messages into space	<i>detectable</i>	able to be discovered or noticed
<i>Drake Equation</i>	a formula for estimating the number of communicating civilizations in our galaxy	<i>Great Filter</i>	a theoretical barrier that stops civilizations from becoming widespread

<i>Zoo Hypothesis</i>	the idea that aliens observe us but choose not to make contact	<i>narrowband</i>	concentrated in a very small range of frequencies, which is unusual in nature
<i>interfering</i>	getting involved in something in a way that changes or disrupts it	<i>phenomena</i>	observable events or occurrences (plural of phenomenon)
<i>staggering</i>	so large or surprising that it is hard to take in	<i>reckless</i>	acting without thinking about the consequences

Discussion & Analysis

Should We Answer? · Lesson Activities

A. COMPREHENSION

1. What is the Fermi Paradox? State it in your own words.

2. What was the Wow! Signal, and what natural explanation was proposed for it in 2024?

3. What is the difference between SETI and Active SETI (METI)?

4. Why did Stephen Hawking compare alien contact to Columbus arriving in America, and how did Jared Diamond describe the Arecibo broadcast?

5. What argument do supporters of Active SETI make in reply to the critics?

6. Which parts of the Drake Equation are better understood today than in 1961, and which remain guesses?

7. What is the Great Filter, and why does it matter whether it is behind us or ahead of us?

8. According to the reading, what might the silence of the cosmos tell us about intelligent life?

B. VOCABULARY IN CONTEXT

Complete each sentence with a term from the vocabulary list. Use each term once.

detectable · extraterrestrial · Fermi Paradox · Great Filter · interfering · narrowband · reckless ·
staggering · transmit · Zoo Hypothesis

1. The telescope picked up a _____ radio signal that seemed unlikely to have come from a natural source.
2. The _____ is the puzzle of why a universe this large and this old appears to be silent.
3. Some researchers want to _____ messages into deep space in the hope that someone will hear them.
4. The number of stars in the Milky Way is _____: at least 100 billion.
5. Critics call Active SETI _____ because we do not know who might receive our signals.
6. The _____ suggests that aliens may be watching us the way scientists watch animals in the wild.
7. If the _____ is ahead of us, most civilizations destroy themselves before they spread across space.
8. A civilization that has never used radio would not be _____ by our current instruments.
9. So far, nobody has found convincing evidence of _____ life of any kind.
10. Wildlife researchers try to observe animals without _____ in their behavior.

C. CRITICAL THINKING

1. If you could add one item to the Voyager Golden Record to represent humanity, what would you include and why?

2. The Drake Equation requires estimating values we do not know. Does that make it useless? What is the value of a formula when most of the inputs are guesses?

3. Compare the Zoo Hypothesis with the Dark Forest Theory from Lesson 1. How are they similar, how are they different, and which do you find more convincing?

4. Hawking and Diamond both argue from human history. Is it reasonable to predict the behavior of an alien civilization from the behavior of humans? Why or why not?

5. The reading suggests intelligent life might not last long. Do you think human civilization is at risk of destroying itself? What are the biggest threats?

D. THE GREAT DEBATE: SHOULD HUMANITY BROADCAST?

Scenario: The United Nations has confirmed a radio signal from a star system 40 light-years away. It appears artificial but contains no message, only a repeating pattern. A committee must decide: should we send a reply?

Position A: Yes, send a reply

Silence is cowardice. We have been leaking radio waves for a century, so they may already know we are here. A deliberate message shows intelligence and good faith. The possible benefits of contact (knowledge, technology, partnership) outweigh the risks. Hiding is not a strategy. It is fear.

Position B: No, stay silent

We know nothing about them. Human history suggests that unequal contact ends badly for the weaker side. At 40 light-years, a question and its answer take 80 years, so we cannot negotiate, only announce ourselves. The risk is existential. Silence costs nothing; a reply could cost everything.

Position C: Reply, but carefully

Send a response, but reveal as little as possible. Acknowledge the signal without giving our population, our technology level or anything else we do not have to. See how they respond before sharing more. Diplomacy, not disclosure.

After the debate, write your own position in three or four sentences. Which argument did you find hardest to answer?

E. DESIGN ACTIVITY: MESSAGE TO THE STARS

Design a message to send to an alien civilization. You cannot use any human language, because they will not understand it. You have a radio signal that can encode images, sounds and mathematical patterns. Consider:

- What information is safe to share? What should you leave out?
- How do you communicate without a shared language? Think about mathematics, music and images.
- What impression of humanity do you want to create?
- The Arecibo Message used binary code to build simple pictures. What would you encode?

Sketch or describe your message in the box, then present it and defend your choices.

F. FERMI PARADOX SOLUTIONS: RANK AND DISCUSS

Rank these six solutions from most convincing (1) to least convincing (6). Compare your ranking with a partner and defend your first and last choices.

___ The Great Filter

Some step on the road to an advanced civilization is nearly impossible to pass. Most never make it.

___ The Dark Forest

Everyone is hiding, because revealing yourself is fatal.

___ The Zoo Hypothesis

Advanced aliens are watching us but choose not to make contact.

___ We Are Early

The universe is young. We may be among the first intelligent species.

___ Wrong Technology

Aliens do not use radio. We are listening for the wrong thing.

___ Self-Destruction

Civilizations destroy themselves before they can travel between the stars.

In one or two sentences, explain your first choice.



Earthrise, photographed by astronaut Bill Anders during Apollo 8 on December 24, 1968. Our only known home in the universe.

Photo: NASA (public domain)

Teacher's Notes & Answer Key

Should We Answer? · Instructor Guide

LESSON OVERVIEW

LEVEL

Advanced (CEFR B2 to C1)

DURATION

60 to 90 minutes

FOCUS

Reading, debate, creative problem-solving

Source material: SETI research history; NASA Voyager mission; Hawking, Diamond, Hanson and Ball on contact and the Fermi Paradox

Series: Humans & The Universe, Lesson 2 of 8. Lesson 1 (The Dark Forest) is recommended first but not required.

SUGGESTED LESSON FLOW

Warm-up (5 min)	Ask: if a message from another civilization arrived tomorrow, what would you want it to say? Open discussion.
Pre-reading (5 min)	Review key vocabulary. Prioritize Fermi Paradox, extraterrestrial, transmit and Great Filter.
Reading (15 to 20 min)	Parts 1 to 4. To save time, students can read Parts 1 and 2 while the teacher summarizes 3 and 4, or the reverse.
Comprehension (10 min)	Section A, as a quick oral check or in writing.
Vocabulary (10 min)	Section B. Ten gaps, word bank supplied.
Debate (15 to 20 min)	Section D, three positions. Assign positions, and push for reasoning based on evidence from the reading.
Creative activity (15 to 20 min)	Section E. Works especially well with analytical or engineering-minded students.
Ranking (5 to 10 min)	Section F as a cool-down. Section C questions can be set as homework or used in a second lesson.

ANSWER KEY: SECTION A (COMPREHENSION)

1. The universe is very old and very large, so intelligent life should be common, yet we have found no evidence of it. The paradox is the gap between what we expect and what we observe.
2. A powerful narrowband radio signal detected on August 15, 1977, by the Big Ear telescope. It lasted 72 seconds, resembled what an artificial transmission was expected to look like, and was never detected again. In 2024 a team led by Abel Mendez proposed that a cloud of cold hydrogen was briefly made to shine by a burst of radiation from a source such as a magnetar. This explanation is not yet confirmed.
3. SETI means passively listening for signals from space. Active SETI, or METI, means deliberately transmitting messages outward and announcing our existence.

4. Hawking's point was that when a more technologically advanced group meets a less advanced one, the result is usually devastating for the weaker side. Diamond called the Arecibo broadcast "suicidal folly" and described astronomers planning further broadcasts as "naive, even dangerous."
5. That Earth has already been leaking radio and television signals for about a century, and that a civilization advanced enough to threaten us could probably detect life on Earth anyway, so staying silent may not protect us.
6. The early terms (star formation and the fraction of stars with planets) are much better understood, because thousands of planets have now been confirmed around other stars. The later terms (how often life, intelligence and technology arise, and how long civilizations last) are still guesses.
7. A theoretical barrier that is extremely hard for life or civilizations to pass. If it is behind us, we are rare survivors and our prospects are good. If it is ahead of us, civilizations typically fail before spreading into space, which would be very bad news for us.
8. That intelligent life may arise often but destroy itself quickly, through war, environmental collapse or dangerous technology. On this view the silence means that civilizations do not last.

ANSWER KEY: SECTION B (VOCABULARY)

1. narrowband 2. Fermi Paradox 3. transmit 4. staggering 5. reckless 6. Zoo Hypothesis
 7. Great Filter 8. detectable 9. extraterrestrial 10. interfering

DISCUSSION EXTENSIONS

Who decides?: Who should decide whether humanity broadcasts? A government, the United Nations, scientists, everyone? Discuss the ethics of one person or group making a decision that affects the whole species. Note that the Arecibo Message was sent without any such consultation.

Research task: Have students research a current search program, such as Breakthrough Listen or China's FAST telescope, and report what it is looking for and what it has found so far.

Link to Lesson 1: In *The Three-Body Problem*, the first novel of the trilogy, the astrophysicist Ye Wenjie answers an alien signal and reveals Earth's position. Was she a traitor or a visionary?

Extraordinary claims: In 2017 the interstellar object 'Oumuamua passed through our solar system. The Harvard astronomer Avi Loeb argued that it could be alien technology; most scientists disagreed. How should we evaluate extraordinary claims? Compare with the Wow! Signal and the 2020 Parkes signal in Part 1.

Section F: There is no correct ranking. Reward students who can explain what evidence would change their minds.

KEY DISCUSSION LANGUAGE

Weighing risks

"The potential benefit is... but the risk is..."

Challenging

"But what about...?" / "That assumes that..."

Historical analogy

"History shows us that..." / "This is similar to when..."

Speculating

"It's possible that..." / "One explanation could be..."

Uncertainty

"We can't be sure, but..." / "Given what we know..."

Evaluating

"The strongest argument for this is..."

Sources & Further Reading

Wow! Signal: detected August 15, 1977, by the Big Ear radio telescope, Ohio State University. Proposed natural explanation: Mendez, Ortiz Ceballos and Zuluaga, "Arecibo Wow! I: An Astrophysical Explanation for the Wow! Signal" (2024).

Galaxy counts: Conselice et al. (2016) estimated about two trillion; analysis of New Horizons data (2021) suggested hundreds of billions.

Stephen Hawking, Into the Universe with Stephen Hawking (Discovery Channel, 2010). Jared Diamond, The Third Chimpanzee, chapter 12.

Voyager distance and the one light-day milestone (November 2026): NASA Jet Propulsion Laboratory.

Robin Hanson, "The Great Filter: Are We Almost Past It?" (1998). John A. Ball, "The Zoo Hypothesis," Icarus (1973).

Humans & The Universe

An eight-lesson advanced reading and discussion series

This lesson is part of a connected series for advanced learners. Each lesson pairs a science fiction premise with the real science, history and ethics behind it, and each works as a standalone class or as part of the full sequence.

1	The Dark Forest: game theory, deterrence and the fate of civilizations	
2	Should We Answer? SETI, the Fermi Paradox and the risk of saying hello	<i>you are here</i>
3	Hibernation and Time: waking up in a future that moved on without you	
4	Living in Space: survival, adaptation and leaving Earth behind	
5	Scarcity and Survival: resources, rationing and who gets to live	
6	First Contact Protocols: diplomacy, danger and speaking for humanity	
7	The Ethics of Technology: power, responsibility and dangerous tools	
8	Endings and Legacy: extinction, memory and what we leave behind	

Lesson 1, The Dark Forest, is a free download from Tahric Teaches on Teachers Pay Teachers.