



Life in the Universe

PHYSICS • UNIVERSE • LIFE IN THE UNIVERSE

Section 1: Life Beyond Earth

• What is SETI?

SETI (Search for Extraterrestrial Intelligence) is the name given to a wide range of activities which seek to find signs of intelligent life elsewhere in the Universe. This can involve using telescopes to search the sky for radio or optical signals, resulting in the collection of enormous amounts of data for analysis. The SETI@home project allowed individuals to help with this task by enabling millions of users to download computer software to analyse data and submit the results. This meant that large amounts of data could be processed without using large supercomputers. SETI projects are ongoing but have not yet confirmed any signals from extraterrestrial civilisations.

• Suggested Film

- SETI: Are We Alone?

Extension Questions

Q1. What was the 'Wow' signal?

In 1977, a radio telescope picked up a strong signal while it was searching the sky for signs of extraterrestrial activity. When the scientist responsible for the measurements saw the result on a computer printout, he circled it and wrote "Wow!".

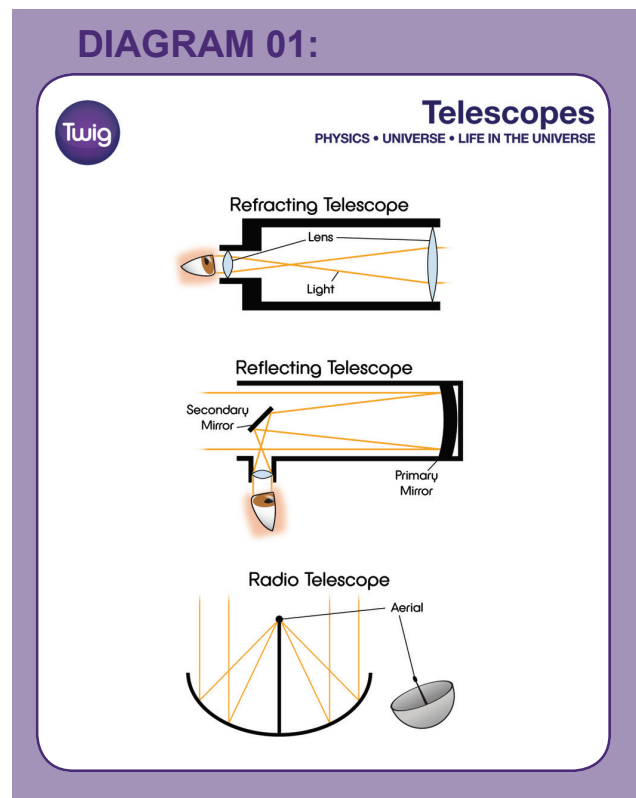
The area of the sky where the source of the signal was located is known, but the source of the signal has never been identified. It is possible that the signal was caused by a source which was on or around the Earth, but no convincing explanation has ever been found. As the signal has only ever been detected on one occasion, despite several searches which have looked at the same region of the sky, it is likely that the reason for the "Wow" signal will never be known.

Q2. What was LGM-1?

In 1967, a radio signal was detected which repeated at regular intervals and lasted slightly longer than a second. It was determined that it was not caused by interference from a signal from Earth, and no known natural source could explain it. While astronomers investigated the source of the signal it was named LGM-1 (Little Green Men).

When the source was finally identified it was found to be a pulsar, a rapidly rotating neutron star. Many pulsars have since been identified, which produce pulses at intervals ranging from about a millisecond to several seconds.

DIAGRAM 01:



Q3. What is the Fermi paradox?

The Fermi paradox was proposed by the physicist Enrico Fermi. It points out that although the age and size of the Universe suggests there should be many advanced civilisations, this is not compatible with our failure to observe them.

Various reasons for the Fermi paradox have been suggested. One explanation is that the estimates may be wrong. Civilisations may be short-lived, perhaps because they tend to destroy themselves, or each other, once they develop sufficient technology, or because natural disasters tend to destroy advanced life before it has the chance to spread. It is also possible that humans are unique and that intelligent life has not arisen anywhere else.

It is also possible that civilisations are too widely separated to communicate, or that they do not wish to communicate with us for some reason. It could also be that we are not listening properly, that civilisations are attempting to communicate in ways we don't understand or are not yet able to detect.



Radio telescopes are used to pick up signals when searching for signs of extraterrestrial activity

• What are exoplanets?

Planets around stars outside our Solar System are known as exoplanets. The light from a star will be far brighter than that from the orbiting planets, and this makes them very difficult to detect. However, improved detection methods led to the first discovery of an exoplanet in 1992. Since then, over 500 planets have been found which orbit stars other than our own. There is great interest in finding planets which orbit within their stars' habitable zone, the region where it should be possible for liquid water to exist on the planet. Several candidates have been identified, and as more are found, it appears increasingly likely that life may exist somewhere else in the Universe.

• Suggested Films

- Planet Hunters
- Planet Kevin

Extension Question

Q4. What is the Drake equation?

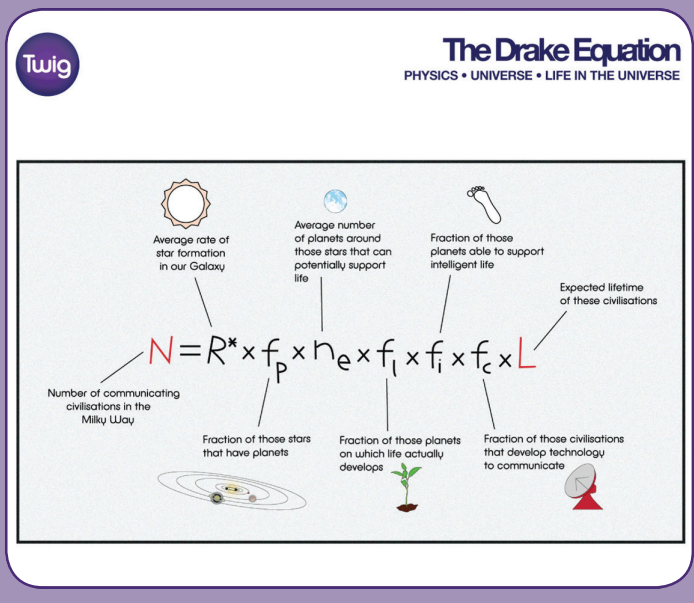
The Drake equation was produced by the astronomer Frank Drake in 1961, and is used to try and estimate the number of intelligent civilisations in our galaxy, which we might be able to communicate with.

It takes the fraction of stars which have planets and multiplies this by the average number of planets, per star, which can support life. It then multiplies this by the fraction of these planets on which life actually develops. Then by the fraction of these which go on to support intelligent life, and the fraction of these which develop the technology to send signals into space. This number is multiplied by the length of time that these civilisations emit detectable signals and the average rate of star formation per year.

Exact values for the seven factors are not available and the value produced by the equation varies widely depending on how they are estimated. Values ranging from less than zero to about 20,000 are easily obtained.

It has been argued that the impossibility of knowing most of the parameters in the equation make it meaningless, but the Drake equation has been useful in stimulating debate among astronomers and other scientists.

DIAGRAM 02:



• Is there water on the Moon?

Water cannot last on the surface of the Moon, but there is a suggestion that water could exist in the permanently dark craters at the poles of the Moon. Various probes may have detected water, but the data is still inconclusive.

If water does exist on the Moon this would make it easier for humans to construct bases there in the future.

• Suggested Films

- Colonising the Moon
- Life in Space
- The Moon



Water can't last on the surface of the Moon

Extension Question

Q5. What is helium 3?

The nuclei of helium atoms normally contain two protons and two neutrons. Helium 3 is a rare form of helium, which contains only one neutron. It has applications in nuclear fusion research. In some circumstances, if helium 3 were used in nuclear fusion reactors the products would be less harmful than those produced by reactions using 'normal' helium. However, helium 3 is rare on Earth. It has been suggested that the Moon could be mined for helium 3, which is deposited there by the solar wind, although it is not clear if this would be economical given the effort required to process large amounts of lunar soil.

Section 2: Mars

• Is there water on Mars?

There is ice on Mars, and if liquid water exists, or has existed, this would increase the chances of life being found. It is believed that liquid water cannot exist on the surface of Mars, although the issue of whether there has ever been liquid water on the surface of Mars in the past, and how recently this occurred, is still unresolved.

• Suggested Films

- Mars
- Mars: The Search for Water
- Next Stop Mars
- Mars: Under the Ice

Extension Question

Q6. What is a Mars sample return mission?

NASA and the European Space Agency (ESA) have suggested that at some time in the future, perhaps around 2020, they would like to conduct an unmanned mission, or a series of missions to return soil samples from Mars. This would allow samples to be analysed on Earth using various methods, and allow more detailed investigation than the current strategy of transporting equipment to Mars to analyse samples there.



It's unlikely liquid water exists on Mars' surface today

• Are there canals on Mars?



The planet Mars has a mostly barren landscape

In the 19th century, astronomers observing Mars thought they could see canals on the surface and some suggested that they may have been built by a Martian civilisation. The belief that there were canals on Mars persisted until the early 20th century when astronomers began to suspect that liquid water could not exist on the surface of Mars.

When probes were sent to Mars in the 1960s they found a mostly barren landscape. There were no sign of canals or features that could have been mistaken for canals. It is now known that the appearance of canals on Mars was an optical illusion.

• **Suggested Film**

- Mars

- Mars: Dead Planet

Extension Questions

Q7. How did the Viking missions try to detect life?

In 1976, NASA's two Viking probes landed on Mars. Both probes conducted experiments to look for signs of life in the Martian soil. It is generally agreed that these experiments did not detect life, although one experiment did return a positive result. This experiment, the labelled release experiment, used a nutrient which contained a radioactive isotope of carbon. It then looked for the release of carbon dioxide containing this carbon. The carbon was found, but as the other experiments were negative it was decided that this was likely the result of chemical rather than biological reactions.

Other, more recent, experiments have found chemicals called perchlorates in the Martian soil. It is thought that these may explain the results of the labelled release experiment. Alternatively, it could mean that any organic molecules in the soil could have been destroyed by the perchlorates, which may be a reason that the Viking probes returned negative results.

Q8. Was life found in a Martian meteorite?

Meteorites have been found on Earth which are known to have originated on Mars. In 1996 it was announced by NASA scientists that possible evidence for life on Mars had been found in 1 of the 34 known Martian meteorites. It was claimed that features found in the rock were examples of fossilised bacteria. However, these were smaller than any known bacteria and the results have been disputed. After further analysis in 2009, the scientists again restated their conclusion that the meteorite contained evidence of life, although others remain unconvinced.

Q9. What is the Mars Science Laboratory?

The Mars Science Laboratory (MSL) is a space probe designed to determine whether Mars has ever been able to support life. It was launched on November 26th 2011 and the Curiosity rover successfully landed on the surface of Mars almost nine months later. The Curiosity rover is the size of a small car and is the largest rover to ever be sent to Mars. It examines the Martian environment, including its climate and geology, in an attempt to determine if life has ever been present there.

Section 3: Titan

• Why is Titan interesting?

Saturn has over 60 moons, but Titan is by far the largest with a diameter of 5100km, which is one and a half times the diameter of the Moon. It is the only moon known to have a dense atmosphere (in fact its atmosphere is denser than Earth's) and the only body, apart from Earth, where it is known that large, stable bodies of liquid exist. The atmosphere is composed of mostly nitrogen. Titan has wind, rain, sand dunes, rivers, lakes and seas, and it is thought that the conditions on Titan may be similar to the conditions on the early Earth, although Titan is much colder. Titan's surface temperature is very low, about -180°C , and the liquid on the surface is thought to be methane, although water may exist beneath the surface of Titan and water ice is likely to exist on the surface.

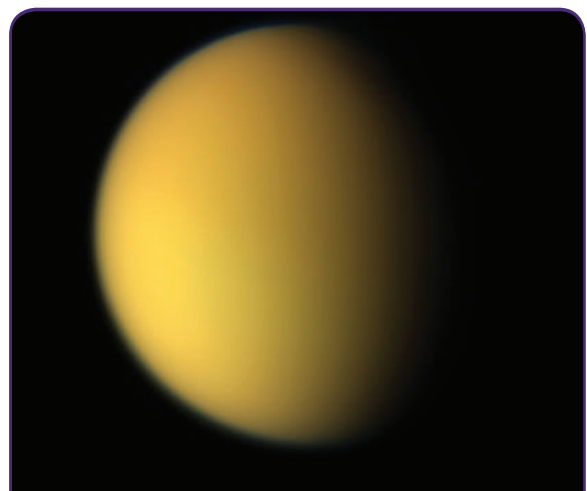
Extension Question

Q11. Is Titan the only moon where scientists think life might be found?

The Cassini spacecraft collected data which suggested that another of Saturn's moons, Enceladus, may have liquid water beneath its surface. It is also believed that there is liquid water beneath the surface of Europa, a moon of Jupiter which is covered in ice. Both of these are of interest to scientists searching for life in the Solar System, as it is believed that there is potential for life to exist in the water beneath their surfaces.

• Suggested Film

- Place Like Home: Life On a Moon



Titan is the largest of Saturn's moons

• What was the Cassini-Huygens mission?

In 1997 the Cassini-Huygens mission was launched. A collaboration between NASA, the ESA and the Italian Space Agency, it was designed to investigate Saturn and its moons. The Cassini spacecraft successfully entered orbit around Saturn, and in December 2004, released the Huygens lander, which entered the atmosphere of Titan in January 2005.

Huygens transmitted data for about 90 minutes, including pictures from the surface and measurements of the composition of Titan's atmosphere. The Cassini spacecraft also conducted measurements, and later confirmed that lakes of liquid hydrocarbons are present on Titan.

• Suggested Films

- Place Like Home: Cassini

- Place Like Home: Inside a Probe

Extension Question

Q12. Are there plans to visit Titan again?

NASA and the ESA are considering a proposal to launch the Titan Saturn System Mission (TSSM) sometime after 2020. The mission would put a spacecraft into orbit around Titan and will also include two landers: a hot air balloon which would investigate the atmosphere and surface, and a lake-lander which would be designed to float on the seas of Titan.

• Quizzes

Life On Mars: Dead Planet

Basic

• What did Percival Lovell think he had discovered when he looked at Mars?

- A – oceans
- B – canals
- C – craters
- D – moons

• Who was Percival Lovell?

- A – an astrologer
- B – a palaeontologist
- C – a chemist
- D – an astronomer

• What was the first NASA spacecraft to take close-up pictures of Mars?

- A – Viking 1
- B – Viking 2
- C – Mariner 4
- D – Mariner 3

• What did pictures of the surface of Mars show?

- A – oceans
- B – a barren landscape
- C – large amounts of ice
- D – rivers

Advanced

• When did a NASA spacecraft first take close-up pictures of Mars?

- A – 1890
- B – 1950
- C – 1965
- D – 1976

• What was the first probe to land on the surface of Mars?

- A – Viking 1
- B – Viking 2
- C – Mariner 4
- D – Mariner 3

• When did the first probe land on the surface of Mars?

- A – 1890
- B – 1950
- C – 1965
- D – 1976

• Answers

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