The probability of life in the Milky Way
Key Stage 4

Topics covered: Drake equation, probability, Milky Way galaxy

Watch the video "Are there aliens?" https://vimeo.com/122515138

In 1961 an American astronomer called Frank Drake devised an equation to estimate the number of planets that have intelligent life in the Milky Way. The Drake equation has 8 terms:

$$N \ = \ R_* f_p n_e f_l f_i f_c L$$

Where:
N = number of civilisations in the Milky Way
R_* = average star formation rate
f_p = fraction of stars that have planets
n_e = average number of planets that are habitable
f_l = fraction of planets that go on to develop life
f_i = fraction of planets that go on to develop intelligent life
f_c = fraction of civilisations that develop communications technology
L = length of time for which civilisation releases signals

1. What factors might affect the success of an intelligent race on another planet?

Frank Drake estimated values for the parameters in his equation:

R_* = 1 star per year
f_p = min 0.2, max 0.5
n_e = min 1, max 5
f_l = 1
f_i = 1
f_c = min 0.1, max 0.2
L = min 1000 years, max 100×10^6 years

2. Find N from the Drake equation using the values above. Calculate an answer for the minimum values (where stated) and an answer for the maximum values estimated by Drake. How do these two answers compare and what do they mean?

The Italian physicist Enrico Fermi thought we should have been visited by intelligent aliens by now and asked the question, **"where is everybody?"**. This is called the Fermi paradox and is based on the following reasoning:

- There are billions of stars in the Milky Way that are similar to the Sun including stars with longer lifetimes – plenty of time for life to evolve.
- Some of these stars are very likely to have orbiting planets that are similar to the Earth.
- On some of these Earth-like planets are intelligent lifeforms that might be developing interstellar travel.
- The journey across the Milky Way could be covered in about a million years.

3. List all the reasons you can think of to explain why we have not been visited by intelligent lifeforms yet.

The probability of life in the Milky Way: **ANSWERS**
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1. Change in global climate; asteroid impact; war;
2. Minimum N = 20; maximum N = 50 million
3. Civilisations have been wiped out by war; periodic extinctions occur due to meteoritic impacts or geological changes; intelligent beings are too far apart to communicate; technology is not advanced enough for them to communicate or travel through the galaxy; humans have existed for only a short period of time; aliens are too different to humans and don't want to communicate with us; they have visited but we didn't detect them; there is no intelligent life elsewhere!