

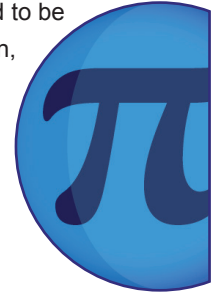


# Binary: The Alien Language

## Key Learning Content

This film tells the story of the message attached to the 1972 Pioneer Space Probe, which was intended to be read and interpreted by alien civilisations. The message contained pictures of a naked man and woman, together with symbols representing the position of Earth in space. Interstellar distances were given in binary form.

While a brief description of binary numbers is given, prior knowledge of binary would be very useful for students watching the film. The film is an excellent starting point for looking at a range of other mathematical topics, from measurement of distances in space, to Newton's law of gravitation.



### Core Outcomes

#### Learning Points

- Be able to understand that the decimal number system is one of many alternative number systems, including binary.
- Be able to use ratio notation, including reduction to its simplest form  $1:n$ .

#### Suggested Activities

- Convert between binary and decimal numbers.
- Calculate distances between planets and the Sun based on the ratios given on the plaque.

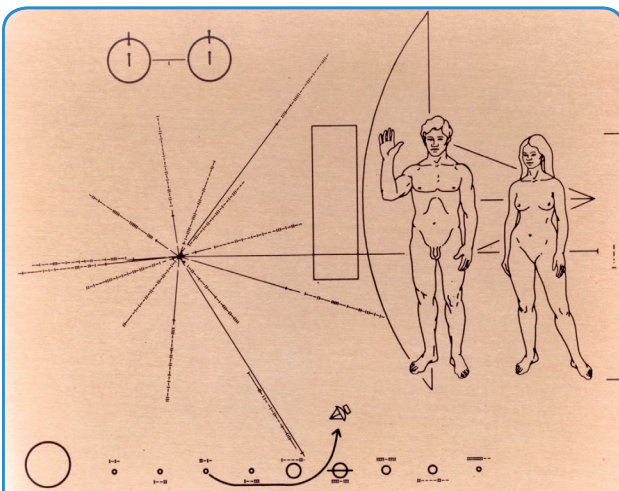
### Extension Outcomes

#### Learning Points

- Be able to use and interpret maps and scale drawings.
- Be able to understand that a vector has both magnitude and direction.

#### Suggested Activities

- Use trigonometry to calculate distances between objects in 2D space.
- Use vectors to describe the position of objects in 3D space.
- Calculate the distance between objects in 3D space using Pythagoras' Theorem.



The Pioneer Plaque shows the figures of a man and a woman, and information about planet Earth

## Related Films

To use before the lesson plan:

### **Binary: What is Binary?**

This film introduces the concept of binary numbers, describes what binary numbers are, and shows how to convert between binary and decimal forms.

### **Binary: The Computer Language**

This film describes the fundamental role of binary numbers in computing, and explains 'bits' and 'bytes' in terms of their underlying binary structure.

To use after the lesson plan:

### **Aiming for the Outer Planets**

This film explains how physicists used the gravitational pull of planets to send probes far into space.

### **Distance to the Sun and Moon**

This film shows how to calculate relative distances in space by taking simple measurements from the Earth.

### **Enigma: Cracking the Code**

This film relates how code-breaking in the Second World War led to the invention of the first computer.

### **Numbers: Life Without Numbers**

This film explores the intriguing possibility that some civilisations may be able to flourish without using numbers.

## Guide Lesson Plan

### Introduction

Tell the students that they have been chosen to compose a message to send to an alien civilisation many light years away. They can only use one side of a sheet of paper. What would they say? Encourage them to give numerical data in their message – how would they communicate it?

### Show Film

### **Binary: The Alien Language**

### Main Activity

#### **Foundation**

Hand out a copy of the plaque shown in the film and get the students to decipher as much of the message as they can, without assistance. Show the film again, and give students more time to complete the task. Invite individuals to describe the message as fully as possible to the group.

Go over the principles of binary numbers and practise further conversion between binary and decimal forms.

**Main Activity cont ...**

**Advanced**

Ask students how they would create a map of the universe showing the position of the objects referred to on the plaque. Discuss the difficulties of drawing 3D maps.

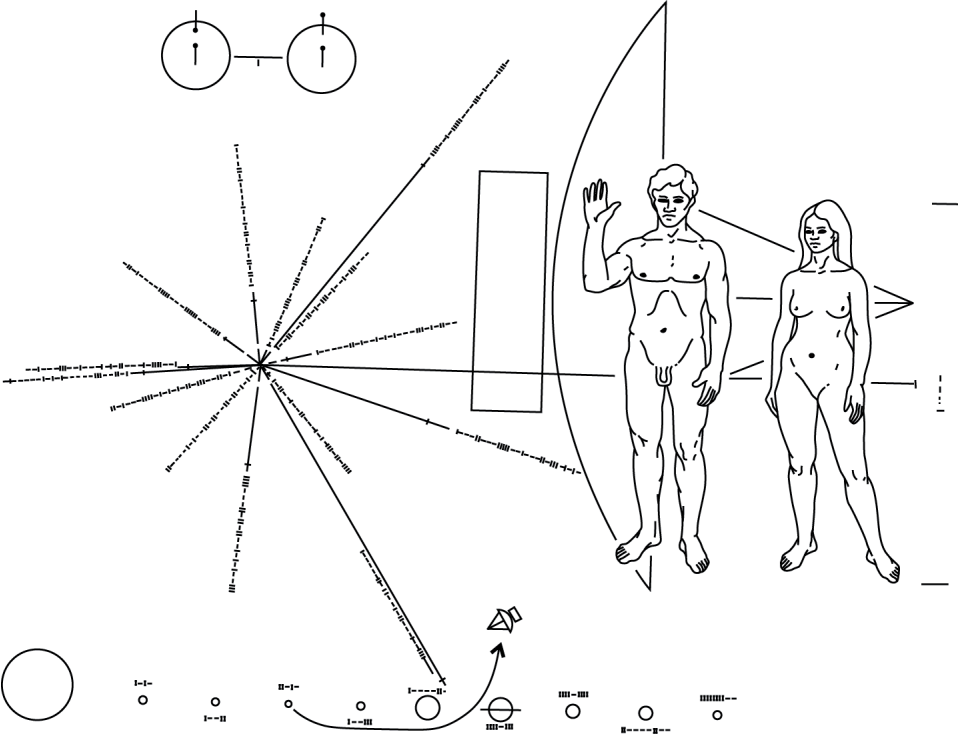
Give students information about the distance and direction of a point A from two other points B and C. Ask them to draw a map of A, B and C and work out the distance from B to C (using scale drawing or trigonometry). Repeat the task giving the coordinates of A, B and C and discuss how this simplifies the task. Next, give the position of three other points in 3D space using  $(x, y, z)$  position vectors and repeat the task. Discuss why a coordinate approach was not used on the plaque.

**Extension Activity**

Get students to research the distances between stars and planets, expressing their results in standard form and as ratios to a given distance.

**Optional Extra**

The Pioneer plaque has raised some interesting cultural as well as mathematical questions. Ask students what they think of the images of the man and the woman on the plaque. Use the internet to research reaction to the portrayal of the couple. If you were designing the plaque today would you present anything differently?



The symbols at the bottom of the Pioneer Plaque depict the planets in our Solar System, and show their distance, in binary code, from the Sun.