

Is there life beyond Earth?

with Dame Dr Maggie Aderin-Pocock

Royal Institution Christmas Lectures Activities

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In this year's CHRISTMAS LECTURES from the Royal Institution (Ri) supported by CGI, Dr Dame Maggie Aderin-Pocock will take us on an epic voyage through time and space.

Scientists in 2025 detected the 'strongest hint yet' of biological activity outside our solar system on exoplanet K2-18b, sparking growing excitement about the real possibility of extraterrestrial life. In this series of lectures, Maggie sets out on a journey to find it.



Decode the Arecibo Message and Make Your Own!

This is a Key Stage 3 school resource to decode an Arecibo message and create your own message.

Learning Objectives

- Learn what the Arecibo Message is
- Design your own Arecibo Message

What is the Arecibo Message?

Over 50 years ago in 1974, scientists sent a one-time message into space using the Arecibo (ah-reh-see-boh) radio telescope in Puerto Rico. The Arecibo Message was sent to Messier 13, a cluster of stars about 25,000 light years away. It was made of 1,679 binary digits, or bits, represented as a 1 or a 0. When arranged into columns and rows these bits formed an image containing information about Earth and humans.

What is in the message?

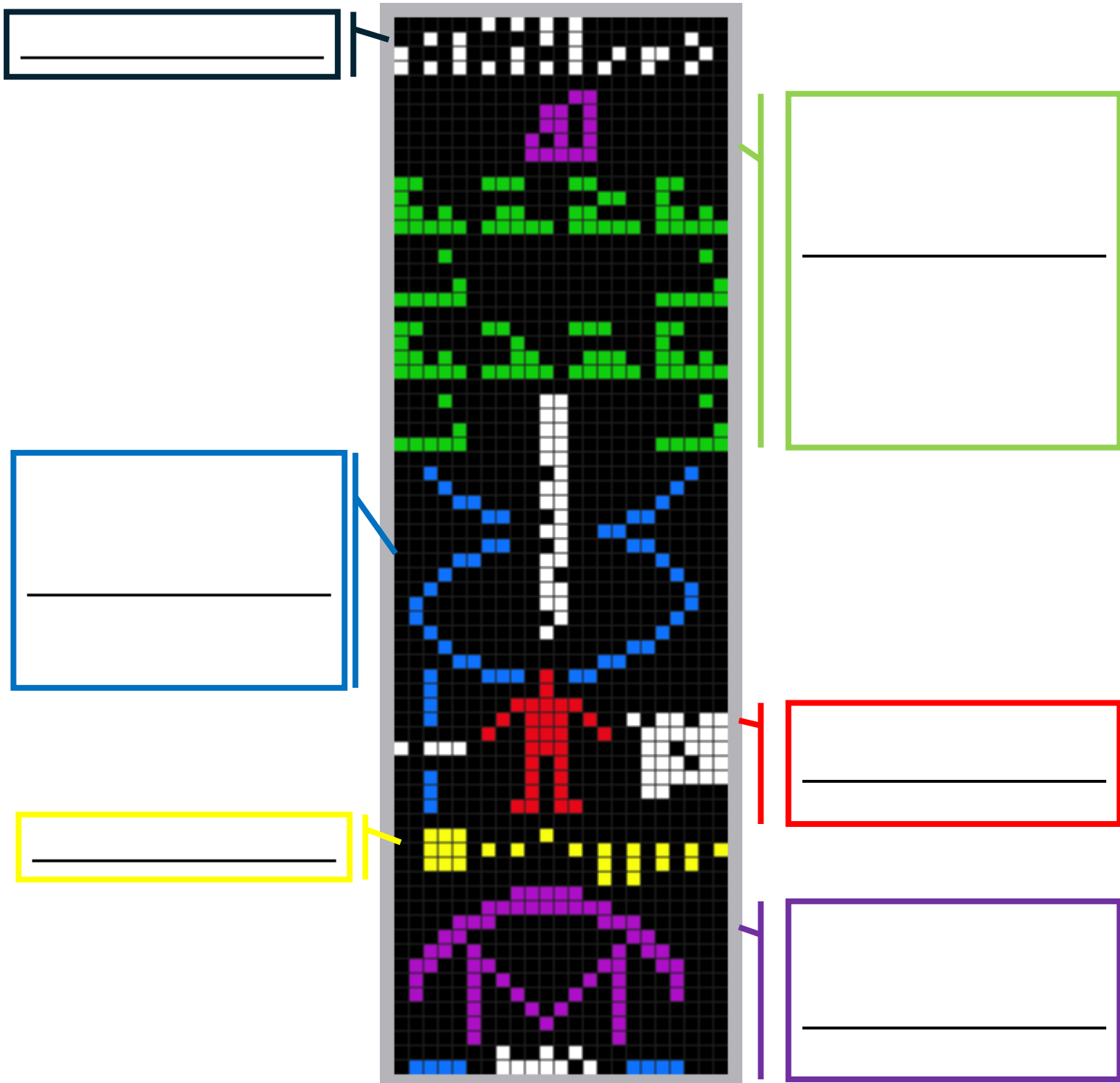
The message had lots of different parts:

- **Numbers from 1 to 10** – to show we understand numbers
- **Atomic numbers of key elements in DNA** – hydrogen, carbon, nitrogen, oxygen, and phosphorus
- **Molecular formulas for DNA building blocks**
- **A Double helix and human figure** – this included the average human height and the population of the world (~ 4 billion in 1974)
- **Solar system diagram** – with Earth higher and near the person to show where we live
- **Arecibo telescope diagram** – including its size

When you put all these elements together it shows an important insight into humanity and planet Earth.

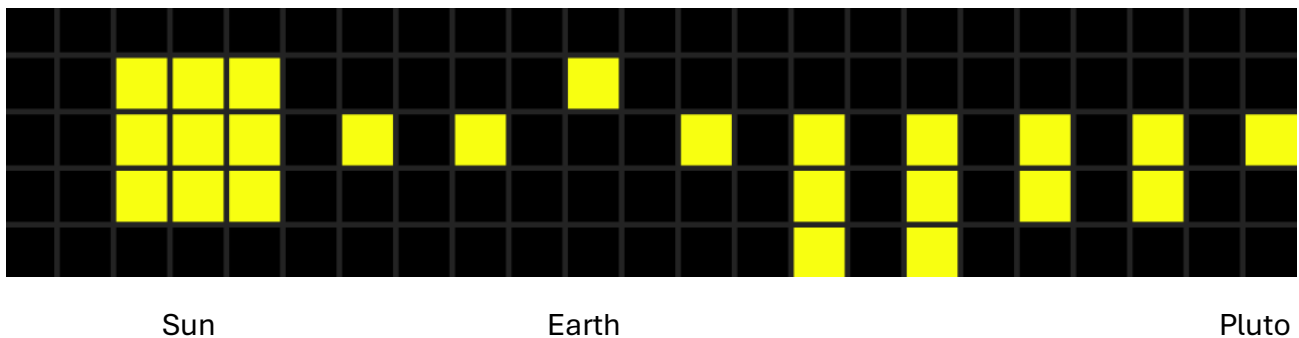
Activity 1: Label the Arecibo Message

Here is what the message looked like (colour has been added to help you see each part more clearly). Label which part of the image you think relates to each part of the message: numbers (1 to 10), Arecibo telescope, human, atomic numbers, solar system, DNA double helix.



Let's go into more detail about some parts of this message.

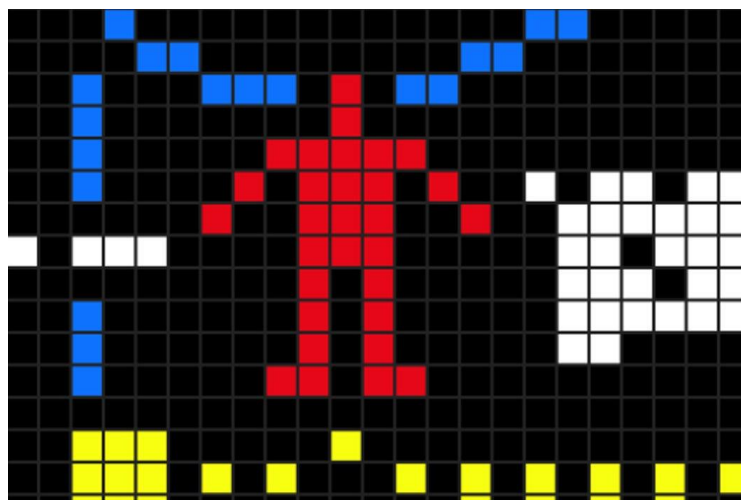
The planets



These pixels here represent our solar system. Pluto **used** to be considered a planet, making 9 planets in our solar system. Now Pluto is considered a dwarf planet, and we have 8 planets in our Solar System. ***Can you label the rest of the planets?***

The Earth is higher than the rest of the planets – to show that this is where we live. Do you think if you were an alien that this would be clear to you?

The person



This area of the message shows:

- The height of an average human man, 5'9" (blue/white, on left)
- A figure of a human being (red, middle),
- The human population of Earth which was around 4 billion when the message was sent (white, on right).

Activity 2: Using Binary Code to make a picture

This message was made of binary code. This is where 0s and 1s make a picture. Here's an example to show how it works:

The 1 digits represent a shaded in part of the image, the 0 digits represent a blank square.

Row 1: 0000000000

Row 2: 0010000100

Row 3: 0000000000

Row 4: 0100000010

Row 5: 0011111100

Row 6: 0000000000

1									
2									
3									
4									
5									
6									

Use these sets of binary code to make an image. Shade in the blocks which are represented by 1s.

Image 1

Row 1: 00110001100

Row 2: 01001010010

Row 3: 10000100001

Row 4: 10000100001

Row 5: 01000000010

Row 6: 00100000100

Row 7: 00010001000

Row 8: 00001010000

Row 9: 00000100000

1										
2										
3										
4										
5										
6										
7										
8										
9										

What does this image show?

Image 2

Row 1: 00100000100

Row 2: 00010001000

Row 3: 00111111100

Row 4: 01101110110

Row 5: 11111111111

Row 6: 10111111101

Row 7: 10100000101

Row 8: 00011011000

1											
2											
3											
4											
5											
6											
7											
8											

What does this image show?

Image 3

Let's reverse it. See if you can work out the binary code from this image

Row 1: _ _ _ _ _

Row 2: _ _ _ _ _

Row 3: _ _ _ _ _

Row 4: _ _ _ _ _

Row 5: _ _ _ _ _

Row 6: _ _ _ _ _

Row 7: _ _ _ _ _

Row 8: _ _ _ _ _

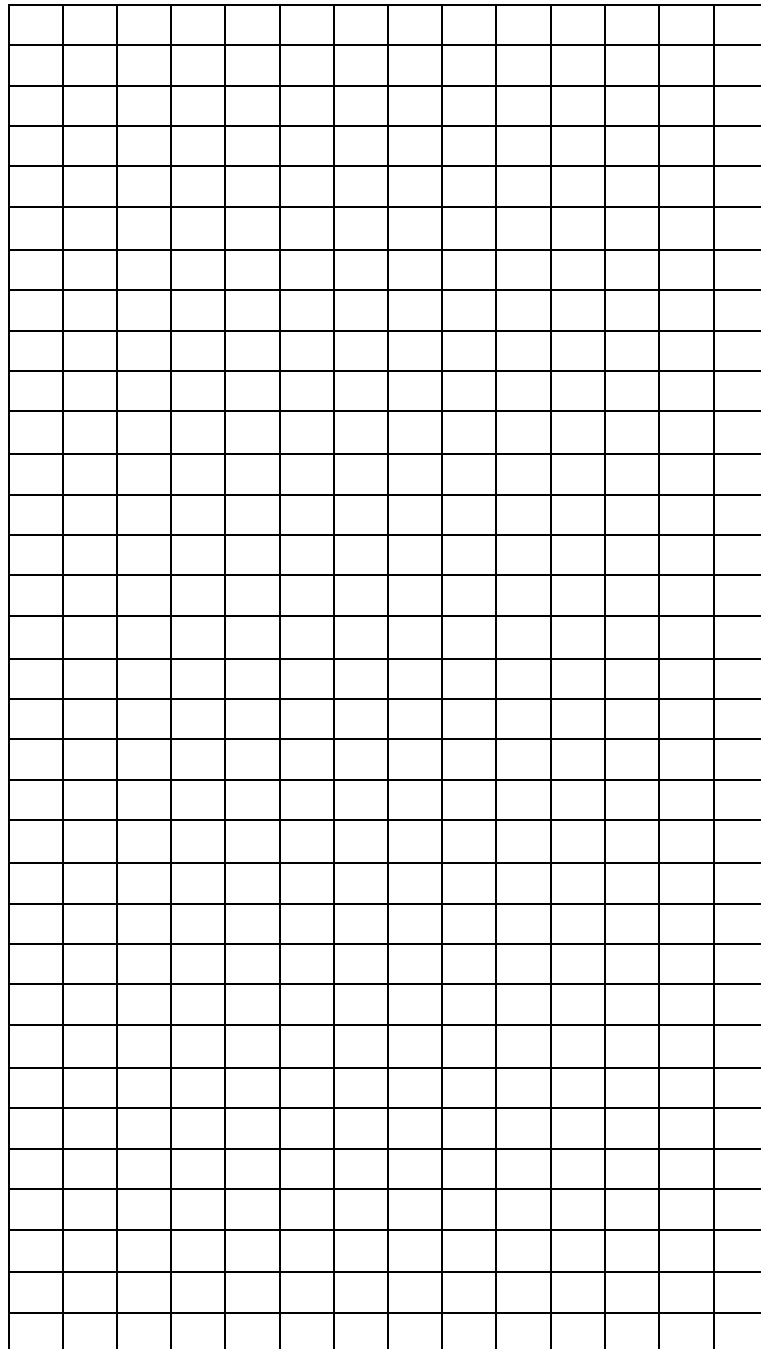
1									
2									
3									
4									
5									
6									
7									
8									

Activity 3: Design Your Own Space Message!

Imagine you want to send a message into space.

- What would you want to say?
- What's important about life on Earth?
- Can you turn your ideas into a picture like the Arecibo message?

Use colours, symbols, and shapes to show what makes Earth special.



Extension:

The Arecibo message isn't the only attempt humanity has made to communicate with intelligent life beyond Earth. In 1977, NASA launched the Voyager Golden Records aboard the Voyager 1 and Voyager 2 spacecraft. These phonograph records were designed to represent the diversity of life and culture on Earth.

The records were identical, and they contained a rich collection including:

- Greetings spoken in 55 different languages
- Natural sounds like thunder, birdsong, and ocean waves
- Musical selections from various cultures and time periods
- Images on the record showing how to play it and scientific information

Challenge:

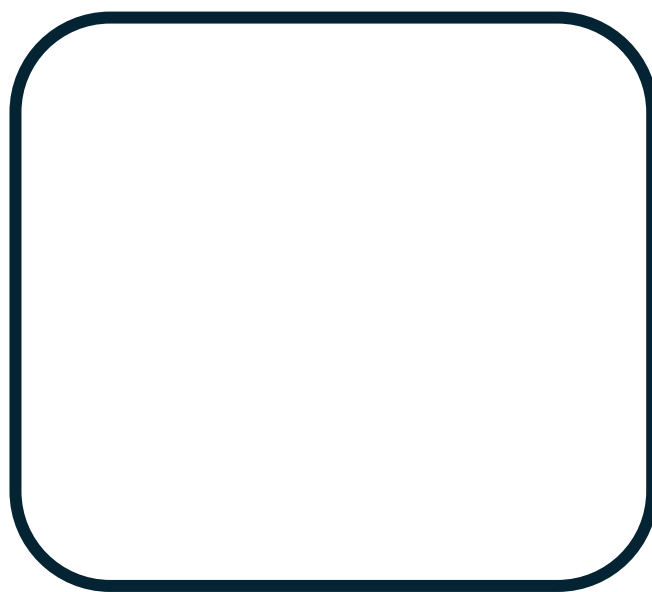
If you were creating a new version of the Golden Record, what would you include?

What messages, sounds, or songs would best represent life on Earth today?

Make a playlist of audio you'd choose—this could include nature sounds, music from around the world, or even personal messages.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Design a playlist cover for your Golden record:



Answer sheet: **Label the Arecibo Message**

Numbers (1 to 10)

Atomic numbers

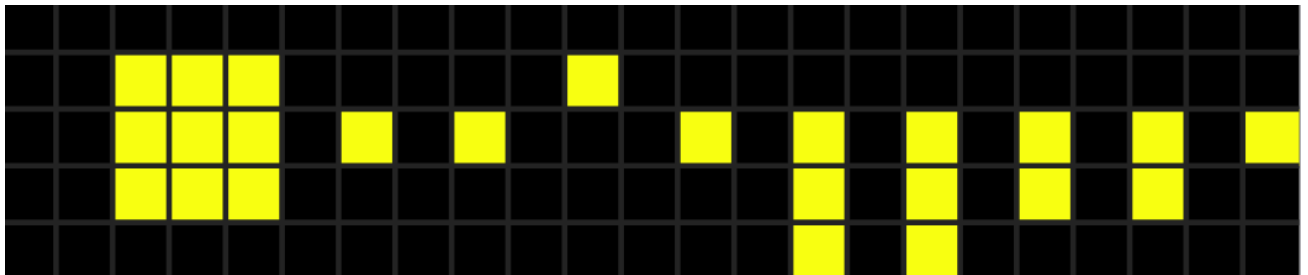
DNA double helix

Human

Solar system

Arecibo telescope

Label the planets:

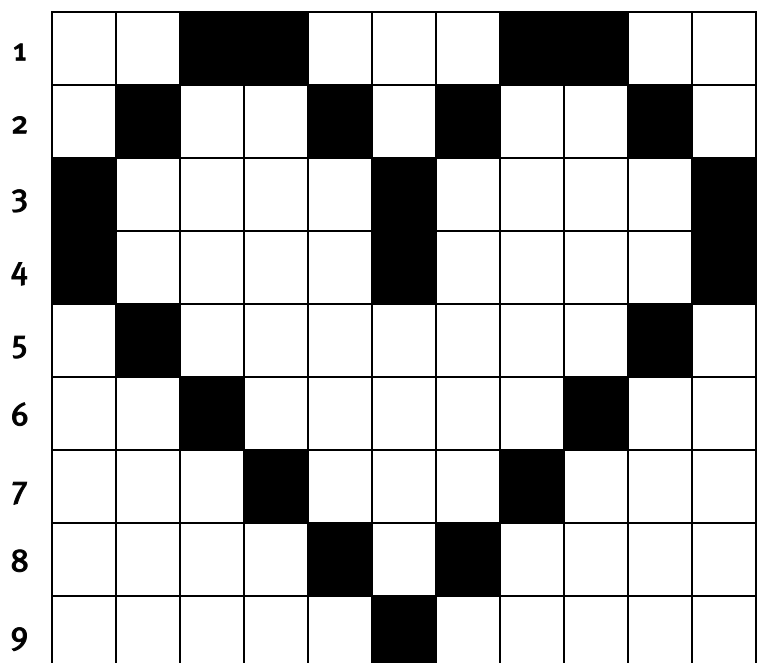


Sun Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto

Activity 2: Using Binary Code to make a picture

Image 1

Row 1: 00110001100
Row 2: 01001010010
Row 3: 10000100001
Row 4: 10000100001
Row 5: 01000000010
Row 6: 00100000100
Row 7: 00010001000
Row 8: 00001010000
Row 9: 00000100000



This image shows a heart

Image 2

Row 1: 00100000100

Row 2: 00010001000

Row 3: 00111111100

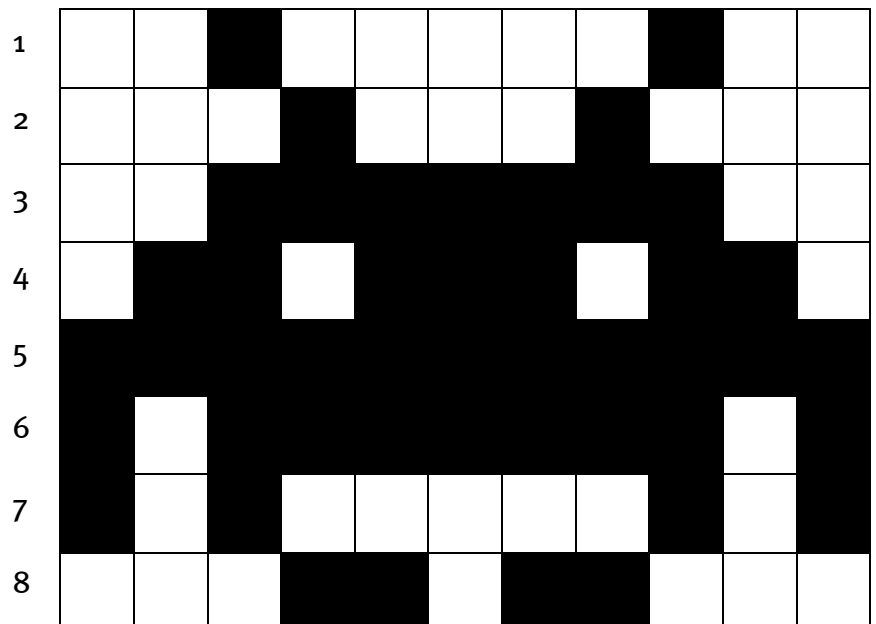
Row 4: 01101110110

Row 5: 11111111111

Row 6: 10111111101

Row 7: 10100000101

Row 8: 00011011000



This image shows a space invader/ alien

Image 3

Image 3

Let's reverse it. See if you can work out the binary code from this image

Row 1: 001101100

Row 2: 001101100

Row 3: 110000011

Row 4: 110000011

Row 5: 001111100

Row 6: 011111110

Row 7: 011111110

Row 8: 001101100

