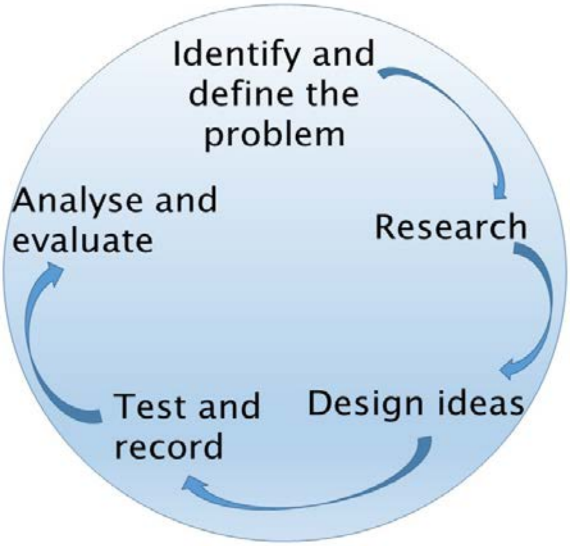
The Challenge

During the late 19th and early 20th centuries, it was believed by some that there were "canals" on Mars, this implied intelligent beings were living on the planet. This was found to be untrue as technology advanced and we were able to get more detailed pictures of the Martian surface. These pictures showed no evidence of infrastructure, however, many scientists believe there is other evidence to suggest there once was, and possibly still is, life on Mars.
Your challenge is to investigate factors which might help us to plan a mission to Mars, in search for life.



Background Information

Mars is our neighbouring planet and has some similarities to Earth. Like Earth, it is a rocky (terrestrial) planet and a Martian day is also only very slightly longer than an Earth day (24 hours and 37 minutes). However, there are also lots of important differences.

Earth's average distance from the Sun is 151.64 million kilometres, whereas for Mars it is 212.39 million kilometres. This means that the Sun's rays are weaker and the average temperature is markedly cooler. The diameter of Mars is also nearly half that of the Earth. Due to its size it also has a lower gravitational pull, and this is part of the reason it has a very thin atmosphere.

NASA started Mars exploration in 1960 with an attempted Mars flyby using Marsnik 1 (https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=MARSNK1).This attempt failed and it wasn't until the Mariner 3 mission in 1964 that NASA had their first successful flyby of Mars, sending back images of the Martian surface to Earth. Since then there have been numerous failed and successful missions, which have helped scientists learn more about the red planet.

Sometimes we get lucky and we don't even have to fly to Mars to get samples of the planet asmany Martian meteorites have been found on Earth. These meteorites help us understand more about the composition of the planet and can provide evidence of life. One very famous meteorite is the Alan Hills 84001 meteorite, which was found in Antarctica in 1984. You can see from the image below it looks like it contains worm-like bacteria. The chemistry of the rock initially indicated that there could be biological traces, however, it was very unclear if this could have been from its time on Earth's surface. Current thinking is that the structures are chemical and not biological, although there are still some scientists who are sceptical about that.

Figure 1. Alan Hills 84001 Meteorite with worm like structures. ((NASA, 1996)

Science
Technology
Engineering and
Mathematics

Background Research

1. How does Mars compare to Earth in volume and density?
2. What is gravity like on Mars as compared to Earth? Why is it different?
3. How does the temperature of Mars compare to that of Earth? Why is the temperature so different?
4. What are the seven signs of life?
5. What is the "Goldilocks zone" and why is it important?
6. What considerations would need to be put in place to send humans to Mars?

Chronology of Mars Exploration

Objective

To research the history of Mars exploration and create an interactive timeline of successful NASA missions. This can be digital or made using paper.

Method

1. Decide if you are going to make a digital timeline or a poster.
2. Print out the Mars exploration timeline (https://nssdc.gsfc.nasa.gov/planetary/chronology_mars.html) and highlight all the successful missions (if it says attempted it was not successful). You will find more details about the missions when you click on the hyperlinks on the exploration timeline.

If you are making a digital timeline you may want to watch some tutorial videos:

- How to make a timeline in PowerPoint
- How to link slides in PowerPoint

Points to consider:

- If you are making a poster, how you will make it interactive and not just a 2D flat picture?
- What scale will you use for your timeline?
- Why did you choose this scale?
- What additional information will you add about the missions?

Results and Analysis

1. Which decade had the most successful missions to Mars?
2. How many missions to Mars have there been in total (including unsuccessful missions)?
3. What fraction of missions have been successful?
4. Is there a relationship between successful missions and time? (Have there been more successful missions in recent years compared to in the past?)
5. Which mission do you think has been the most important to date? Why?

Evaluation

1. How clear is your timeline for displaying the history of Martian exploration?
2. Was your scale sensible for the amount of information you had to show?
3. How interactive was your timeline?
4. What improvements could you make to your timeline?

Martian Landings

Objective

To consider where might be the best locations to land a rover on Mars to look for life.

Research

1. What conditions are required for life to exist?
2. What could provide energy for life on Mars?
3. Has water been found on Mars, if so where, and why is this important?
4. Explain the landing process to get a rover onto Mars. Illustrate the steps through diagrams (like a cartoon).
5. What are some difficulties with getting the rovers to land in an exact location, considering the landing process?
6. How could the gradient of an area affect the landing process of a rover?
7. What powers the Martian rovers, and what are some issues with this?
8. Where will the rover get the most energy, near the equator or the poles?
9. How far can a rover travel each sol (Martian day)?
10. Go to https://www.google.com/mars/ and select elevation. Which colours are used to represent high areas, and which are used to represent low areas?
11. Still on Google Mars, click on spacecraft. Is there any relationship to where landers have landed and the elevation?
12. Still on Google Mars, is there any relationship between the landing sites of the rovers and where water is found?
13. What evidence might a rover be searching for when looking for life?
14. Print out the map of Mars from Google Mars and select three possible landing sites you would recommend for a rover. Why did you choose those locations?
15. What are the pros and cons of each landing site?

Parachute Design

To minimise impact speed on landing, it is vital that the Martian rover is slowed down. One method that is used to do this is by employing a parachute.

Objective

To plan and conduct an investigation to determine how the size of a parachute relates to the speed at which an object falls.

Hypothesis

Create a hypothesis for your investigation.

Equipment

Write a list of the equipment you will need to conduct your investigation.

Method

Write a step by step method explaining how you will conduct the investigation to make it a fair test.

Safety

Are there any hazards in the investigation? What safety precautions will you take to minimise these?

Results and Analysis

1. Display your results as a table and a bar chart.
2. Was there any relationship between the size of the parachute and the amount of time taken to fall?

Evaluation

1. What variable(s) did you keep the same in this investigation?
2. What variable did you change in this investigation?
3. Was this a fair test?
4. Was your hypothesis supported?
5. How many trials did you do for each parachute size?
6. How could you improve this experiment?

An initiative supported by Woodside and ESWA

Extremophiles

Objective

To research the hazards for life on Mars and determine if there is evidence that life could survive these hazards and possibly exist on Mars.

Research

1. What are some hazards to life on Mars?
2. Has there been any suggestion that there could be life on Mars?
3. What is an extremophile?
4. Give examples of types of extremophile and the environments they can survive in:
5. Which type/s of extremophiles would be best adapted for life on Mars? Why?
6. How can studying life on Earth help us to look for life on Mars?
7. Do you think that there could be life on Mars? Why/ why not?
8. What do you think life would be like on Mars if we found some? Add a labelled diagram.

Coding a Rover

As Mars is so far away and it takes too long to reach (at least 9 months), to date there have been no manned missions to it. This means that all rovers must be operated remotely, by people on Earth. Martian rovers not only move over the surface of Mars taking photos, they also complete lots of sampling (atmospheric, soil composition etc.).

Objective

To create a maze challenge for another team then to safely navigate a robot through someone else's maze challenge and map the journey giving step-by-step directions.

Equipment

- Robot such as an Ozobot, Sphero, Dash-Dot, EV3 Lego Mindstorm
- iPad/computer with software for the robot
- Cardboard boxes/ blocks or large piece of paper and thick coloured pens (if you have an Ozobot)
- Stopwatch

Method

This will depend on which type of robot you have.

Ozbot

If you have an Ozbot use a large piece of paper to mark on some sites of scientific interest on the Martian surface that the other teams will have to navigate to and take "samples". You can indicate how they take samples using their Ozbot.

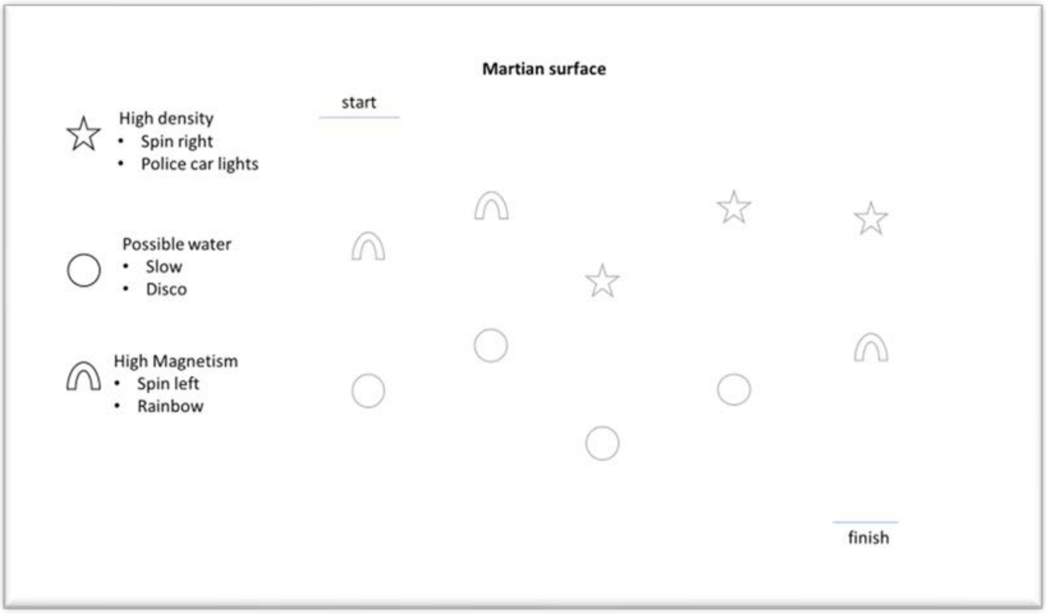


Figure 2: An example map of the Martian surface with interesting places marked on and examples of how to take samples.

Give your route to another group for them to code their robot to follow it – initially they may do a line drawing code, however, as we cannot draw on Mars, they will eventually have to create a click code using Ozoblockly to instruct the robot what to do.

If multiple groups have completed the task you could race them to see which group has planned the fastest route.

Try another teams challenge. Save your code.

Other Robots

If you have a Sphero, Dash-Dot or Lego Mindstorm you can create a maze using cardboard boxes/ blocks. Mark a start and finish on the floor, but make sure you have included some dead ends to make the maze more challenging.

Get another group to code their robot to get through the maze. You can time how long it takes them to complete the challenge and race them against other groups.

Have a go completing another groups maze.

Here are some ideas for mazes:

- https://www.youtube.com/watch?v=8gSKCijQfos
- https://www.youtube.com/watch?v=iB1GJvsPV_o
- https://www.youtube.com/watch?v=uWDhNM8L_zg
- https://www.youtube.com/watch?v=Ro7T3q14uDY

Evaluation

1. How easy was it to code your robot to follow a maze and complete ‘sampling’ tasks?
2. How do you think your maze compares to the Martian landscape that a rover has to navigate over?
3. Due to the distance that Mars is from Earth it takes a long time for signals to reach the rovers (20 minutes on average). What difficulties could this cause?

   To find out more about communicating with the rovers read this article: https://mars.nasa.gov/mer/mission/timeline/surfaceops/navigation/

   Have a go at driving a Martian rover on this game from NASA: https://mars.nasa.gov/gamee-rover

Designing a Martian Rover

Objective

To design and build a model Martian rover.

Design Ideas

Analyse previous rover designs. What are the pros and cons of each design when looking for evidence of life on Mars?

What do you think are some of the most important features for a Martian rover to have to help it look for signs of life?

Considering what you have learnt from your research draw a labelled model of your design idea.

Equipment

Write a list of equipment that you will need to make your Martian rover.

Method

Write a step-by-step method of how you will make and test your Martian rover. Ensure you consider any safety precautions you will need to take. Show this to your teacher and make any necessary changes before making the rover.

Testing

How will you test your rover to determine how well it could work on Mars?

Evaluation

1. How well does your rover move over uneven ground?
2. How does your rover compare to that of an actual rover? For example, do you have to push it, or can you operate it remotely?
3. Do you have any sampling tools on your rover? For example, a camera?
4. What improvements could you make to your rover?