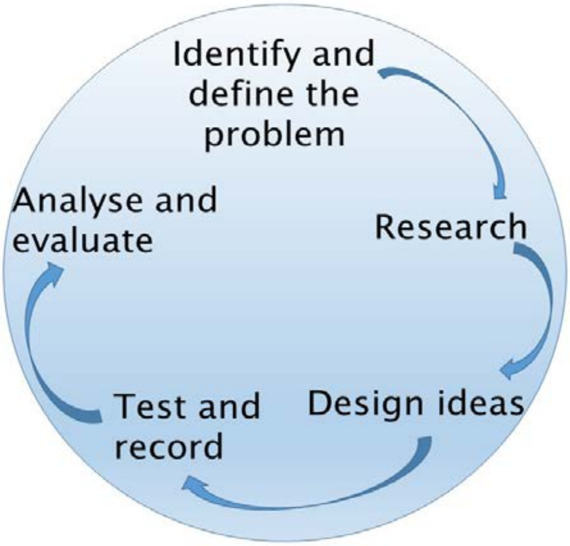
The Challenge

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)

Background Research

1. How does Mars compare to Earth in volume and density?

2. How does the temperature of Mars compare to that of Earth? Why is the temperature so different?

3. What are the seven signs of life?

4. What is the "Goldilocks zone" and why is it important?

Chronology of Mars Exploration

Objective

To research the history of Mars exploration and create an interactive timeline of successful NASA missions.

Equipment

- Large roll of paper (wallpaper is good)
- Meter rule
- Pencil and pens
- Coloured paper (A4)
- Glue stick

Method

1. 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).
2. Cut the coloured paper into four and fold each piece of paper in half to make a little booklet, so that you have one booklet for each successful mission.
3. On the front of each booklet write the name and date of the mission, and then on the inside write dot points providing key information about the mission (you will find more details about the missions when you click on the hyperlinks on the exploration timeline)
4. On the roll of paper decide on a scale for the timeline which will fit all the missions on without being too squashed up or far apart.
5. Stick your booklets onto the paper and connect them to the timeline with lines, so that they are in chronological (time) order.

Results and Analysis

1. Which decade had the most successful missions to Mars?

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2. How many missions to Mars have there been in total (including unsuccessful missions)?

3. What fraction of missions have been successful?

4. 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. What improvements could you make to your timeline?

3. Was your scale sensible for the amount of information you had to show?

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. Has water been found on Mars, if so where, and why is this important?

3. Explain the landing process to get a rover onto Mars. Illustrate the steps through diagrams (like a cartoon).

Suggested websites: https://www.youtube.com/watch?v=XRCIzZHpFtY, https://spaceplace.nasa.gov/mars-sojourner/en/

4. What are some difficulties with getting the rovers to land in an exact location considering the landing process?

5. What powers the Martian rovers, and what are some issues with this?

6. How far can a rover travel each sol (Martian day)?

7. 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?

8. Still on Google Mars, click on spacecraft. Is there any relationship to where landers have landed and the elevation?

9. Still on Google Mars, is there any relationship between the landing sites of the rovers and where water is found?

10. What evidence might a rover be searching for when looking for life?

11. Print out the map of Mars from Google Marsand select three possible landing sites you would recommend for a rover. Why did you choose those locations?

Science
Technology
Engineering and
Mathematics

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 investigate how the size of a parachute relates to the speed at which an object falls.

Hypothesis

What will happen to the length of time it takes for the object to fall as the size of the parachute increases?

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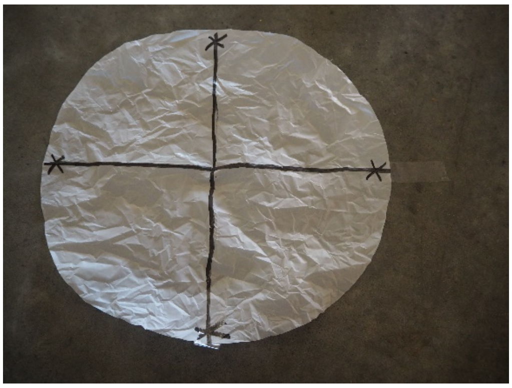
Equipment

- Bin bags
- Hole punch
- Sticky tape
- Cotton
- A small toy/weights
- Different sized circular objects or a drawing compass
- Marker pen
- Stopwatch
- Ruler
- Scissors

Method

1. Draw around one of the circular objects, or use a compass to draw a circle onto the bin bag.
2. Cut out the circle and stick 4 pieces of tape equally spaced apart over the edge of the circle. (These will help stop the plastic from ripping)




3. Use the hole punch to make a hole where the tape is.
4. Measure the diameter of the circle and record it in the table.
5. Cut four equal length pieces of cotton (around 40 cm), thread one end through the holes in the parachute and tie in a knot. Tie the other end to the toy/weight.
6. With a partner, one of you go to the top of some stairs/a balcony and the other wait at the bottom.
7. Making sure there is no one in the way below, drop the toy/weight off the edge of the balcony and tell the person at the bottom to start timing immediately.
8. Stop timing when the toy has hit the ground. Record the time in the table below.
9. Repeat the investigation with different sized parachutes.

Results and Analysis

Diameter of Parachute (cm)	Time to fall (s)

1. Draw a bar chart to display your results.

2. Was there any relationship between the size of the parachute and the amount of time taken to fall?

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Evaluation

1. What variable(s) did you keep the same in this investigation?

2. What variable(s) 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?

Extremophiles

Objective

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

Research

1. What are some hazards to life on Mars?

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2. Has there been any suggestion that there could be life on Mars?

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3. What is an extremophile?

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4. Give examples of types of extremophile and the environments they can survive in:

Type of extremophile	**Environment it can live in**

5. Which type/s of extremophiles would be best adapted for life on Mars? Why?

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6. How can studying life on Earth help us to look for life on Mars?

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7. 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 safely navigate a robot through a maze challenge.

Equipment

- Robot such as an Ozobot, Sphero, Dash-Dot, EV3 Lego Mindstorm
- iPad/computer with software for the robot
- Cardboard boxes 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.

If you have an Ozobot you can start by planning a route on a piece of paper that you want the Ozobot to follow, making the robot stop at points to take samples (this can be shown by making the robot spin or complete another move). 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 you have a Sphero, Dash-Dot or Lego Mindstorm you can create a maze using cardboard boxes. 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.

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? Consider factors such as size, strength, number of sampling tools, manoeuvrability and how it will get energy.

Rover **(photo and name)**	**Pros**	**Cons**

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.

Science Technology Engineering and Mathematics

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

1. 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?

An initiative supported by Woodside and ESWA

3. Do you have any sampling tools on your rover? For example, a camera?

4. What improvements could you make to your rover?