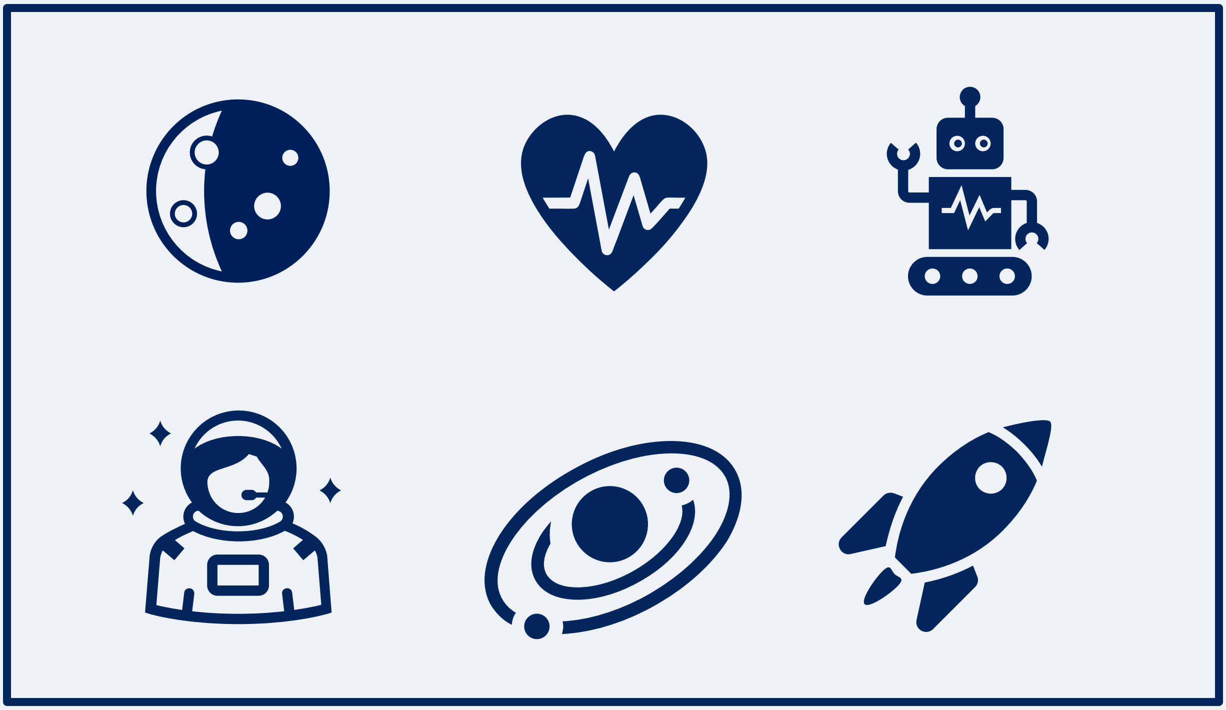
# Can We Get Humans to Mars?



## Student Workbook

THE SCHOOLS' OBSERVATORY

FUNDED BY A PARTNERSHIP GRANT FROM THE ROYAL SOCIETY

PROUD TO BE PART OF LIVERPOOL JOHN MOORES UNIVERSITY

## Table of Contents

# Investigation 1

# Where Should We Build a Moon Base?

# Where Should We Build a Moon Base?

## Introduction to your Mission

Humans want to go to Mars, but it's a big journey! First, we must practise living beyond Earth. The best place to start is the Moon.

In this mission, you are part of a team of geologists. Your job is to explore the surface of the Moon, learn about its features, and decide where to build a Moon base.

## Activity: Explore the Moon Surface

Use the key below and the feature stickers to mark as many features as you can on your piece of the Moon.

In the white boxes below, write down how many of each you spotted?

| | |
|---|---|
| **Sea / Mare** | |
| **Mountain / Mon** | |
| **Valley / Vallis** | |
| **Crater** | |
| **Unusual** | |

Write a short description of one feature:

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

# Where Should We Build a Moon Base?

Stick your labelled piece of the Moon below:

## Activity: Moon Jigsaw Puzzle

- Work with your group to put together the big Moon puzzle.
- Use the Moon map below to guide you.
- Make sure the pieces are the right way up (look for arrows).

# Where Should We Build a Moon Base?

## Activity: Choose a Moon Base Site

Use a dot sticker to mark on the Moon map on the last page where you think your Moon base should go.

I chose this site because:

______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________

## Activity: Taking a Moon Observation

Write your username and password given to you by your teacher in the table below to log in to The Schools' Observatory website.

| My username | My password |
| --- | --- |
| | |

Follow the instructions given to you to take an observation of your Moon base site.

Name of Moon section:

# Where Should We Build a Moon Base?

Add your Moon observation image below. Use a dot sticker to mark your Moon base.

# Investigation 2

# What Do Humans Need to Survive?

# What Do Humans Need To Survive?

## Introduction to your Mission

Now that we have chosen the site for our Moon Base, we need to know what to include inside of it so humans can live there.

First, we must understand what resources humans need to survive…

## Activity: Resources for Survival

Write down what resources are essential for survival in space.
Extension – Tick which resources are easier to get on Earth vs the Moon or Mars.

___

___

___

___

## Activity: Essential or Extra

Put a tick in either the 'Essential' or 'Extra' column for each item.
Extension – Add 2 more items and put a tick in one of the columns.

| Item | Essential | Extra |
|---|---|---|
| Oxygen | | |
| Pizza | | |
| Pets | | |
| Music | | |
| Beds | | |
| Hot Showers | | |
| Plants | | |
| Video Games | | |
| | | |
| | | |

## Activity: Comparing the Earth, Moon, and Mars

Add a label for 'Earth', 'Moon', and 'Mars' to each of the scales below.

**Average Temperature**

*Hottest*

*Coldest*

**Strength of Gravity**

*Strongest*

*Weakest*

**Atmospheric Density**

*Thickest*

*Thinnest*

Why can't humans breathe on the Moon and Mars?

Why are we testing our base on the Moon before going to Mars?

## Activity: Sustainable Earth

List some ideas of how we can live more sustainably.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

## Activity: Basecamp Design

Create a planned diagram for your base using the design template (on the next pages).

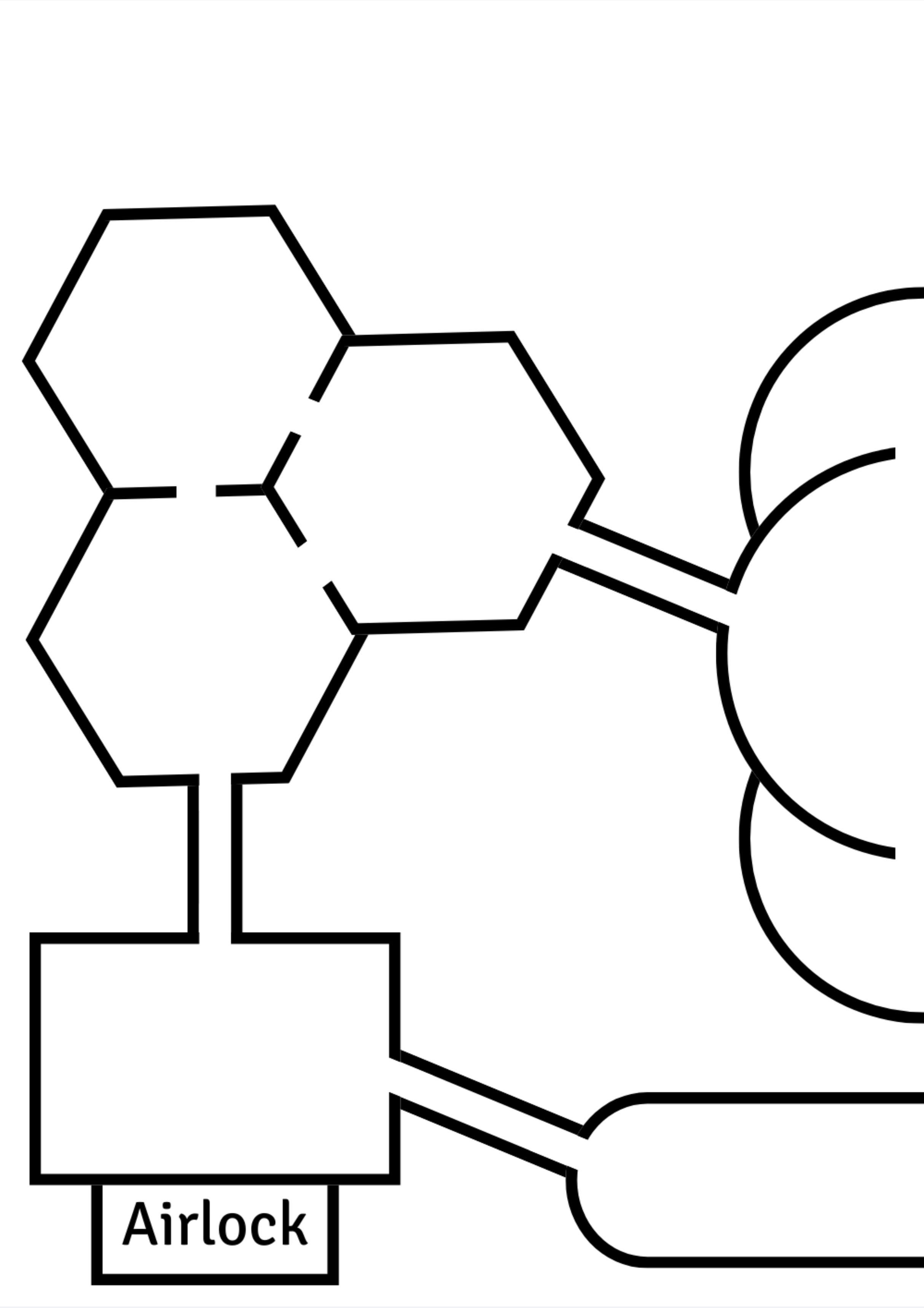
Your base needs to include these 9 main features:

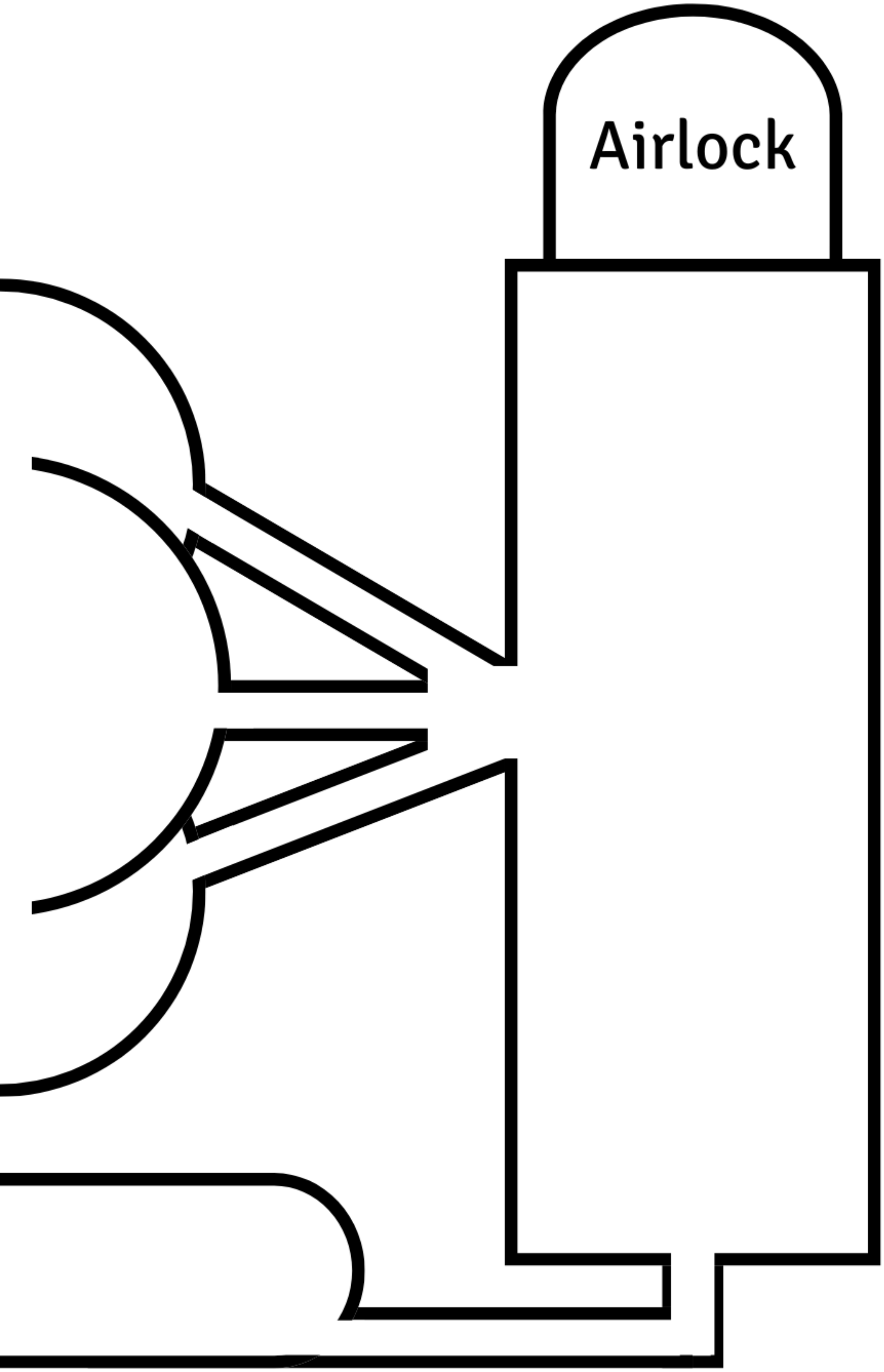
- Food Supply Room
- Water Systems Room
- Communications Room
- Bedroom
- Bathroom
- Living Quarters with Kitchen
- Electricity/Power Supply Room
- Medical Room with Gym and Air Supply Systems
- Science Lab

The design template has 9 rooms, so you must assign one main feature to each room. Think about what items and equipment you'll need in each type of room.

Draw everything you will include in your base! You might want to add some labels to your diagram as well.

*Design your basecamp on the next pages!*


Airlock


Airlock

# What Do Humans Need To Survive?

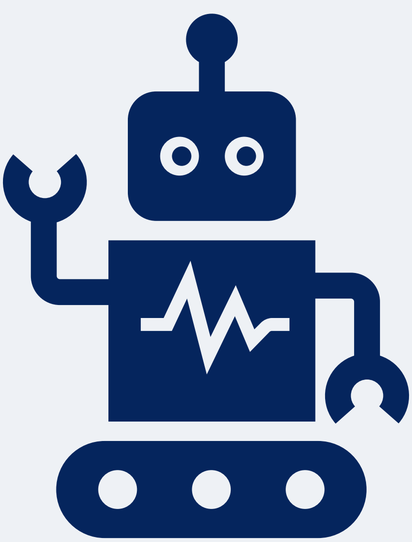


What is your favourite thing about your Moon Base?

How will this help you to live healthily and happily in space?

# Investigation 3

# How Do You Control a Robot Rover?



# How Do You Control a Robot Rover?



## Introduction to your mission

Now that we know how to design bases beyond Earth, we are going to take the next step towards exploring Mars.

Before humans can go to Mars, we must send robotic rovers first to learn more about the planet. Your team will become engineers and programmers, coding rovers to complete missions on Mars.

## Activity: Landing a Rover

Watch the video carefully.

What are the challenges we might face when sending and landing a rover on Mars?

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

## Activity: Coding a Rover

- Talk with your team and decide a name for your rover. Write it down in the white box.
- Write down the mission title from your mission card in the box below.

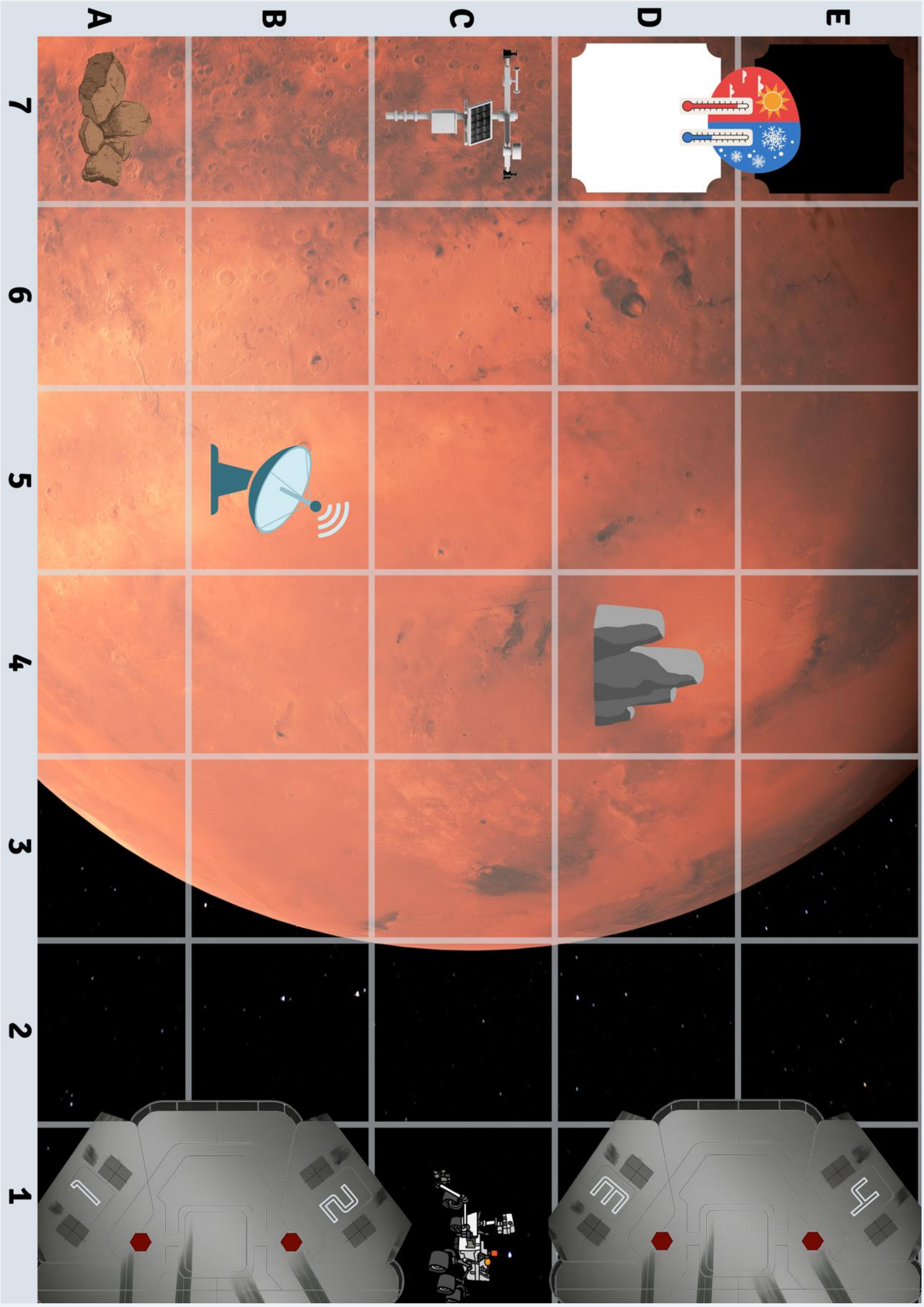
**Rover Name:**

**Mission Title:**

# How Do You Control a Robot Rover?



**Plotting & Planning**: Use the Mars canvas grid below to plan your rover's journey. Write or draw your planned path here.



# How Do You Control a Robot Rover?

**Coding:** Write or draw the coding blocks you used.

# How Do You Control a Robot Rover?



**Recording:** Write your rover's readings from your mission below

Our Readings:

What does your Reading represent?

# Investigation 4

# How Do We Stay Healthy in Space?

## Introduction to your Mission

Now that we know what to include in a basecamp off-Earth, and the ways we can utilise robot rovers to carry out missions, we now need to understand how to keep our bodies healthy while living and working on Mars.

You will act as health professionals (such as medics, nutritionists, physical trainers) and explore how to stay healthy in space.

First, let's look at why astronauts need to train…

## Some Dangers of Human Space Exploration

Our bodies aren't made to live in space. Being in environments different to Earth's can change how our bodies function. Astronaut training helps to minimise the risks of these changes.

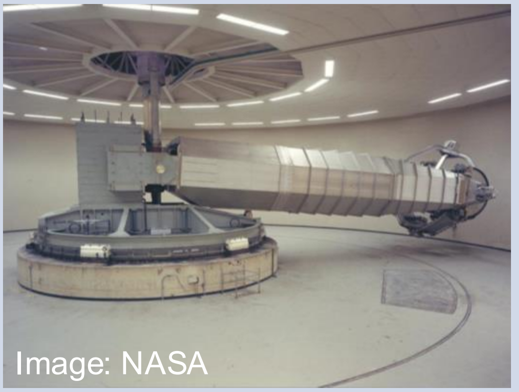


Image: NASA

<u>Travelling in a Rocket:</u>
Large forces act on rockets when they take off and return to Earth. Astronauts feel like there's a weight pressing into their bodies, and this risks them losing consciousness.

They train to withstand the forces by using human centrifuges – a big piece of equipment that spins a person around to simulate what it's like in a rocket.

# How Do We Stay Healthy in Space?

Low Gravity:

Every time we move, we work against gravity. The Mars and Moon, which are smaller than Earth, have weaker gravity. Less force pulls down on the body, so bones and muscles lose strength over time.

To counter this, astronauts exercise for a few hours each day. Cycling and running on treadmills keep bones strong, and weight-lifting is good for muscles.

Image: NASA

Space Environment:

There is no air to breathe in space, and it can be extremely hot when facing the Sun and freezing cold in the shade.

Astronauts wear spacesuits for protection. But they are big and thickly padded, so limit mobility. Astronauts train and perform drills in spacesuits to get used to moving around in them.

## Activity: Mission Control

1. Raise your left foot behind you to around knee-height.
2. Get another person to start the stopwatch.
3. Bounce the ball off the wall and catch it whilst balancing on your right leg.
4. Stop the stopwatch when the ball is dropped or if you lose balance.
5. Record the number of seconds in the results table.
6. On your next turn, repeat the steps again, but balance on your left leg instead.
7. Keep switching legs and repeating until you've completed 3 attempts or until you move on to the next activity.

| | Left Leg | Right Leg |
|---|---|---|
| Time: 1st attempt (seconds) | | |
| Time: 2nd attempt (seconds) | | |
| Time: 3rd attempt (seconds) | | |
| Average Time (seconds) | | |

# How Do We Stay Healthy in Space?

Did you balance better on your left or right leg?

________________________________________

How do your results show that you balanced better on that leg?

________________________________________

________________________________________

________________________________________

Why might your balance be better on that leg compared to the other?

________________________________________

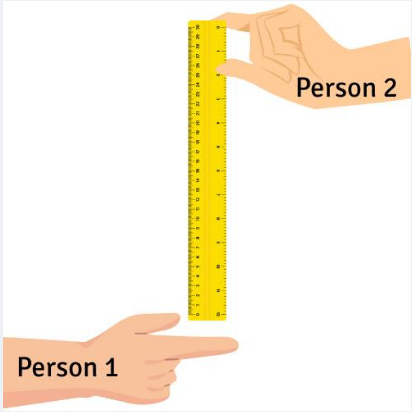
________________________________________

________________________________________

________________________________________

________________________________________

## Activity: The Speed of Light




1. Hold out your dominant hand with your arm straight. Make a fist and then point your thumb and index finger forwards (shown in the picture as Person 1).

2. Have another person hold the ruler between your thumb and finger (shown in the picture as Person 2). The 0cm line of the ruler should be level with the top of your thumb.

3. Without warning, have the other person let go of the ruler so it falls between your thumb and finger.

4. Catch the ruler between your thumb and index finger.

5. Measure the distance between the bottom of the ruler and the top of your thumb.

6. Record the distance in the results table.

7. Use the Distance-Time chart to find your reaction time. Choose the distance that is closest to your measurement.

8. Record the reaction time in the results table.

9. Repeat again when it's your turn until you've completed 3 attempts or until you move on to the next activity.

# How Do We Stay Healthy in Space?

| Attempt | Distance (centimetres) | Reaction Time (seconds) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| Average | | |

*Distance-Time Chart*

| Distance (centimetres) | Reaction Time (milliseconds) |
|---|---|
| 5 | 100 |
| 7.5 | 120 |
| 10 | 140 |
| 12.5 | 160 |
| 15 | 180 |
| 17.5 | 190 |
| 20 | 200 |
| 22.5 | 220 |
| 25 | 230 |
| 27.5 | 240 |
| 30 | 250 |

The standard unit of distance is metres (m). 1 metre = 100 centimetres. Calculate your average distance in metres.

The standard unit of time is seconds (s). 1 seconds = 1000 milliseconds. Calculate your average time in seconds.

What could have a negative effect on your reaction time and make it worse?

## Activity: Planet You Go, Gravity You Find

1. Stand on the start line.
2. Squat while holding Ball A with your arms extended out in front of you.
3. Get another person to start the stopwatch.
4. Jump forwards and lift the ball above your head as you jump.
5. Land and squat again while holding the ball out in front of you.
6. Keep performing the jumps until you reach the end line.
7. Stop the stopwatch.
8. Record the time in the results table.
9. On your next turn, repeat the steps with Ball B and then with Ball C.

| Ball | Time (seconds) |
|---|---|
| A | |
| B | |
| C | |

# How Do We Stay Healthy in Space?

Which ball was the easiest to jump with?

______________________________________________

How do your results show which ball was the easiest to jump with?

______________________________________________
______________________________________________
______________________________________________
______________________________________________

Imagine you lifted the same object on Earth, the Moon, and Mars. Which ball matches what it would be like to lift the object in these places?

Write the correct letter next to each one.

Earth: Moon: Mars:

Explain your answers. Include data from your results table.

______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________

## Activity: Crew Assembly Training

1. Stand in a line with your teammates at Basecamp.
2. Have one team member start the stopwatch.
3. The last person in the line picks up a building piece.
4. Pass the piece to the team member in front until it reaches the person at the front of the line.
5. Take the piece to the Assembly Area and put it down.
6. Return to Basecamp and join the back of the line.
7. Pick up another piece and repeat the process, building your structure on each turn. If your structure falls at any point, follow the steps below:
   i. All team members return to Basecamp and add a tally mark in the '*Number of Penalties*' row.
   ii. The team nominate one person to go to the Assembly Area and rebuild the structure.
   iii. The nominated person returns and goes to the back of the line.
8. Repeat until the structure is finished.
9. Stop the stopwatch and record the time in the '*Time to Complete*' row.
10. Every penalty is 10 seconds. Calculate and record the '*Penalty Time*'.
11. Add this to your original time and record in the '*Total Time*' row.

# How Do We Stay Healthy in Space?



| | |
|---|---|
| **Time to Complete (seconds)** | |
| **Number of Penalties** | |
| **Penalty Time (seconds)** | |
| **Total Time (seconds)** | |

Give one way your team worked well together and one way you could improve.

## Activity: Astro Agility Course

1. Lie face down at the starting line. Place your hands by your shoulders, like you are about to do a push-up.

2. Have another student start the stopwatch and say “Go”.

3. Jump to your feet.

4. Complete the course without knocking over or moving any of the equipment out of place. (Another student can keep count of how many times this happens – each is a penalty).

5. Have the student stop the stopwatch and record your time in the ‘*Time to Complete*’ column.

6. Record your number of penalties in the results table.

7. Every penalty is 2 seconds. Work out the time for all your penalties and record this in the ‘*Penalty Time*’ column.

8. Add this to your original time and record this in the ‘*Total Time*’ column.

9. Repeat again when it’s your turn until you’ve completed 3 attempts or until you move on to the next activity.

# How Do We Stay Healthy in Space?



| Attempt | Time to Complete (seconds) | Number of Penalties | Penalty Time (seconds) | Total Time (seconds) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| Average | | | | |

What was the most challenging part of the Astro Agility Course? How could you improve your performance on this part?

## Activity: Crew Strength Training

1. Stand up straight with feet shoulder-width apart and arms at your side.

2. Have another student start the stopwatch/timer.

3. Complete squats for 30 seconds, counting each time. Keep your back straight and don't extend knees over toes. Lower until thighs are parallel to the floor and then lift again.

4. Record how many squats you did in the results table.

5. On your next turn, get into a plank position with your arms straight. Your hands should be shoulder-width apart.

6. Have another student start the stopwatch/timer.

7. Complete push-ups for 30 seconds, counting each time. Only your hands and feet should ever touch the floor. Lower until your body is parallel to the floor and then lift again.

8. Record how many push-ups you did in the results table.

9. Repeat the steps until you've completed 3 attempts for each or until you move on to the next activity.

# How Do We Stay Healthy in Space?

| Attempt | Number of Squats | Number of Push-ups |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| Average | | |

Do you have better upper-body or lower-body strength? Use your results to explain your answer.

What exercises would improve the strength in the weaker part of your body?

## Activity: Jump For The Moon

1. Find your pulse on your wrist or neck.

2. Start the stopwatch and count your heartbeat for 10 seconds.

3. Record this in the '*Before: Heartbeats in 10 seconds*' column.

4. Multiply the number by 6 and record this in the '*Before: Heart Rate*' column.

5. Restart the stopwatch and skip with the rope for 1 minute.

6. Repeat steps 1 to 4, but record your results in the '*After: Heartbeats in 10 seconds*' and '*After: Heart Rate*' columns.

7. On your next turn, repeat the steps until you've completed 3 attempts or until you move on to the next activity.

# How Do We Stay Healthy in Space?

| | Attempt 1 | Attempt 2 | Attempt 3 | Average |
|---|---|---|---|---|
| Before: Heartbeats in 10 seconds | | | | |
| Before: Heart Rate (beats per minute) | | | | |
| After: Heartbeats in 10 seconds | | | | |
| After: Heart Rate (beats per minute) | | | | |
| Change in Heart Rate (beats per minute) | | | | |

How did your heart rate change after skipping for 1 minute?

___________________________________________

Why did this change happen?

___________________________________________

___________________________________________

___________________________________________

___________________________________________

___________________________________________

## Activity: Do a Spacewalk

1. Sit at the starting point with your knees bent. Place your arms behind you with your hands touching the floor.

2. Lift up from the ground (facing upwards) so only your hands and feet are on the ground.

3. Walk forwards in this crab position. If you reach the edge of the activity area, turn around and walk to the opposite end. Repeat again whenever you reach the edge.

4. Stop when you're too tired or if anything other than your hands and feet touch the floor.

5. Place a marker where you stopped.

6. Measure the distance from the starting point to the marker. If you turned around, include the length of the activity area as well (if you did more than 1 turn, you'll need to add the total number of lengths you covered).

7. Record the distance in the results table.

8. On your next turn, repeat the steps until you've completed 3 attempts or until you move on to the next activity.

# How Do We Stay Healthy in Space?



| Attempt | Distance |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Average | |

What exercises might help you to improve and travel a further distance?

# Investigation 5

# Why Does Mars Change Size?

# Why Does Mars Change Size?

## Introduction to your Mission

Now that we know what we need to create a basecamp on Mars, and to stay healthy on the journey, we need to work out how to get there!

First, we need to understand where Mars sits in the Solar System…

## Activity: Map the Solar System

Name the planets in order of distance from the Sun:

| | |
|---|---|
| 1. | 5. |
| 2. | 6. |
| 3. | 7. |
| 4. | 8. |

**Step 1:** Follow the instructions to create a scale map of the Solar System.

**Step 2:** Stick your map in your workbook in the space provided below:

**Step 3:** Note the scale size of your Solar System map:

1 mm = km

## Activity: Orbit Math's!

As Mars and the Earth orbit the Sun at their set distances, they do not orbit in a straight line.

- Earth orbits at a distance of around **150 million km** from the Sun.
- Mars orbits at a distance of around **228 million km** from the Sun.

This makes the average distance **between** the orbits of Earth and Mars

*Mars orbit (km) – Earth orbit (km) = Distance between orbits (km)*

In astronomy, these distances are so large that we use a new unit instead of kilometres called the Astronomical Unit (AU).

**1 Astronomical Unit (AU) = around 150 million km**

Calculate the distance from the Sun to Earth in Astronomical Units:

*Earth orbit (km) ÷ Astronomical unit (km) = Earth orbit (AU)*

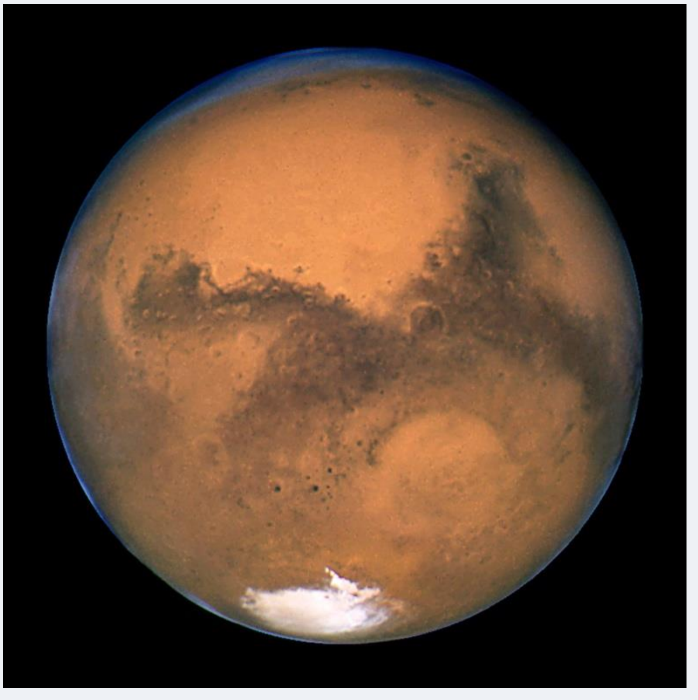
Calculate the distance from the Sun to Mars in Astronomical Units:

*Mars orbit (km) ÷ Astronomical unit (km) = Mars orbit (AU)*

So, the distance between the orbits of Earth and Mars in Astronomical Units is:

*Mars orbit (AU) – Earth orbit (AU) = Distance between orbits (AU)*

## Activity: Measure Mars!



The next few pages have images taken of Mars from the Liverpool Telescope – the same telescope you used to look at the Moon!

It lives on La Palma, one of the Canary Islands of Spain.

The same telescope took all these images of Mars from the same place.

We are showing you the images zoomed in to the same amount.

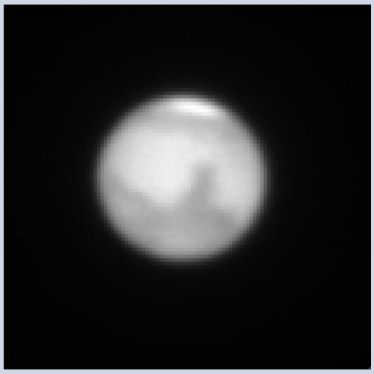
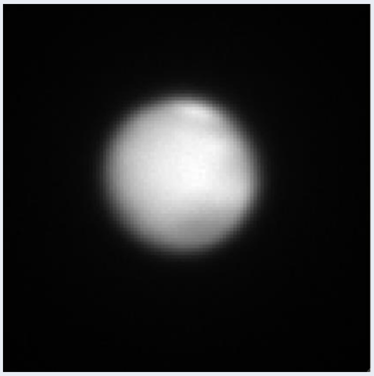
So why do they look different?

Measure the size of Mars and record your data in the table provided – then plot the graph to see how the size changes over time.

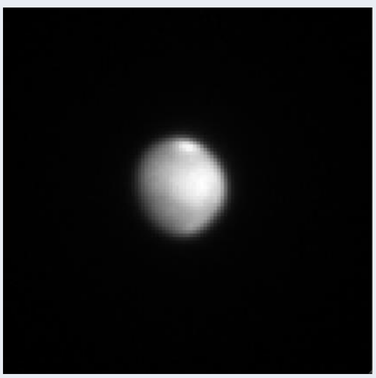
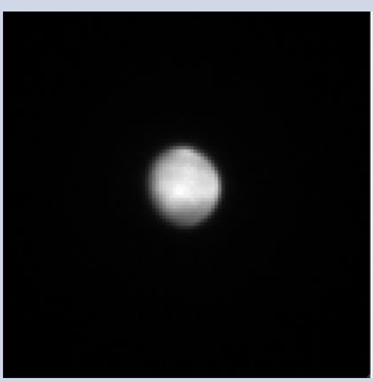
**Can you work out why?**

# Why Does Mars Change Size?



| Mars Observation | Observation Details |
|---|---|
|  | Observation 1<br><br>Date: 16/1/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |
|  | Observation 2<br><br>Date: 2/2/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |
|  | Observation 3<br><br>Date: 10/2/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |
|  | Observation 4<br><br>Date: 20/2/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |

# Why Does Mars Change Size?

| Mars Observation | Observation Details |
|---|---|
|  | Observation 5<br><br>Date: 11/3/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |
|  | Observation 6<br><br>Date: 26/3/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |
|  | Observation 7<br><br>Date: 22/4/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |
|  | Observation 8<br><br>Date: 22/5/2025<br>Telescope: Liverpool Telescope<br>Location: La Palma, Spain |

**Recording the data**

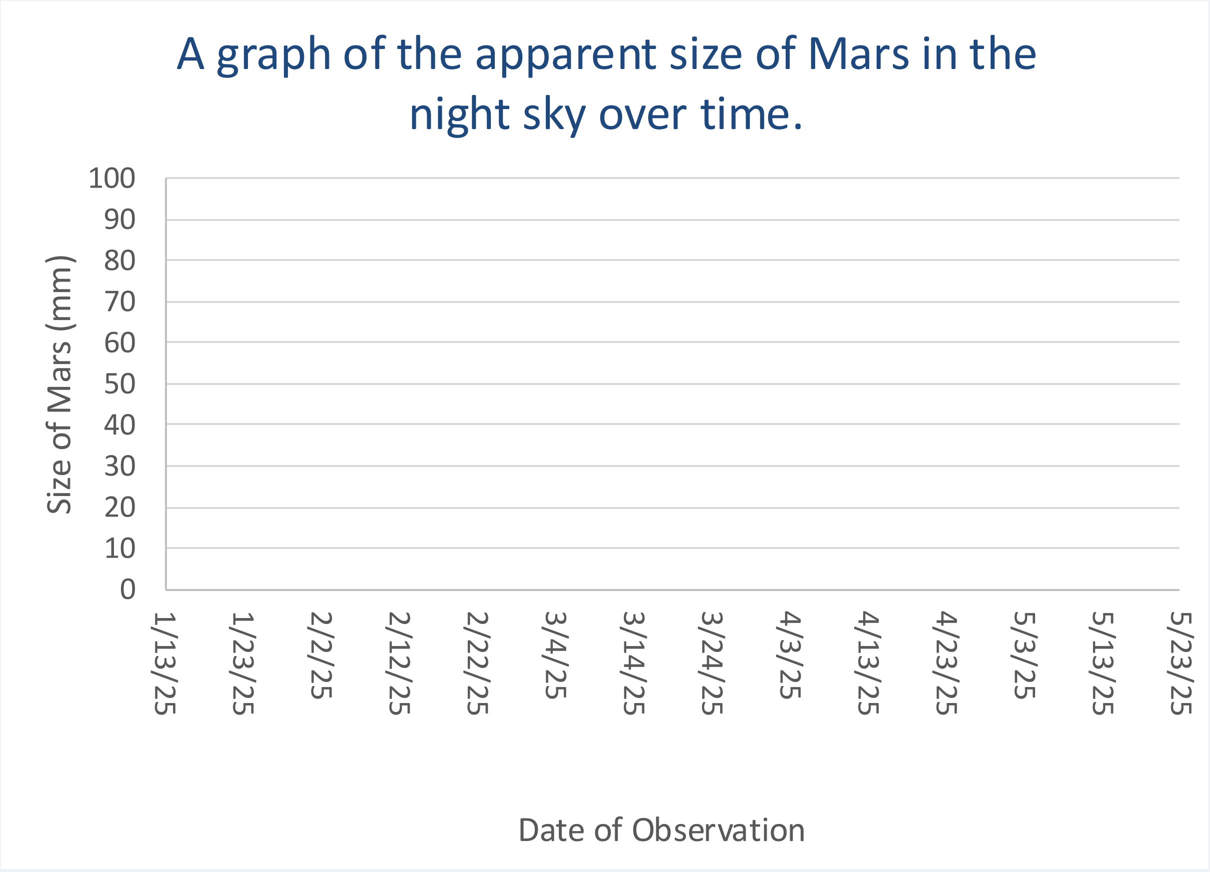
- Measure the size of Mars on each observation as accurately as possible to the nearest mm (millimetre).
- Take 3 readings for each observation and then find the average for the 3.
- Record your data in the table below:

| Observation | Date of Observation | 1 | 2 | 3 | Average |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

# Why Does Mars Change Size?

## Plotting the data

Using the average value for each observation, plot your data points on the graph below.




## Questions

At what date is Mars the largest in the sky?

Why does Mars appear to change size in the night sky?

# Investigation 6

# When Should We Launch to Mars?

# When Should We Launch to Mars?

## Introduction to your Mission

Now that we know what we're prepared for our mission, we need to pick a launch date!

## Activity: Travelling to Mars

We found out in Investigation 5 that Mars is really far away.

How long do you think it would take to travel there in a spacecraft?

I think it would take ______ (days/weeks/months/years) to get to Mars!

It would take about [ ] days to get to Mars.

Calculate this in months (assume 30 days in each month).

Calculate this in years.

It's important to carefully plan a launch date to Mars to make sure that the distance the astronauts must travel is as short as possible – we do this by looking at models of the Solar System called orreries!

## Activity: Electric Orrery

| Date checked | Are Earth and Mars close together? | Notes |
|---|---|---|
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |
| | Yes / No | |

Date of next closest approach:

# When should we launch to Mars?



## Activity: The Launch Date

What is your launch date to Mars?
*Date of closest approach – days to get to Mars =*

*Work out your launch date (use the number of days in each month):*

| J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |

*Your launch date:*

Pick a launch time! What time will you launch?

*Using a 12-hour clock:*

*Using a 24-hour clock:*

Calculate how long it is until you launch:

*Years:*
*Months:*
*Days:*
*Hours:*
*Minutes:*

COUNTDOWN CLOCK!

## Activity: First Words

When the first person set foot on the Moon (Neil Armstrong in 1969), he had carefully planned his first words.

Around 650 million people tuned into the TV to watch the Moon landings live, and those first words were very important.

We still know them to this day:

> "That's one small step for man,
> one giant leap for mankind."
>
> *Neil Armstrong, July 20, 1969.*

When the first person sets foot on Mars, those first words will be just as important.

What would your first words be when you first set foot on Mars?

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# Extra Pages