Your Mission MARS DIARY

ACTIVITY 4.1
TEAM WORK

From the Chapter Four of the Mission Mars Diary

marsdiary.org/activities/team-work

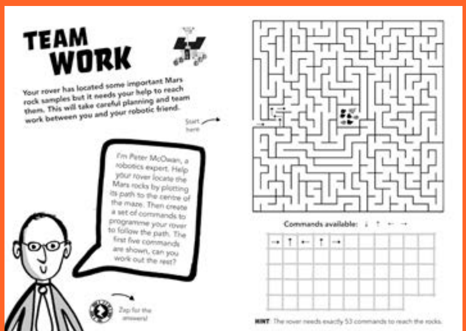
LEARNING LEVEL

KS2, P5-7, Y4-6

CURRICULUM LINKS & DIFFERENTIATION IDEAS

View detailed curriculum links for England, Scotland, Northern Ireland and Wales in the Teacher Toolkit, plus differentiation ideas for your region and year level.

marsdiary.org/resources/#teacher-toolkit



Resources Required

- Smartphone or device for Zap code (optional – see Useful Links)
- Images from ExoMars rover
- Labelled diagram of the rover
- Blind folds
- Access to laptop (optional)
- Roamer (optional)

Background to this Activity

This activity encourages students to use their problem solving abilities as they try to find a way to pilot their rover through a maze using the provided commands.

ExoMars 2020 is an unmanned mission. No astronauts are travelling with the rover to Mars, or will be stationed on Mars to control it. This means that the rover will be programmed to operate almost autonomously, and will be controlled and monitored from ESA's Mission Control on Earth.

Students who followed Tim Peake's mission in 2015-16 may remember that while he was on the ISS, Tim controlled a test rover located at Airbus Defence and Space in Stevenage, England. This experiment involved Tim guiding the rover through a mock-Mars environment, to test whether we can operate robots while we are orbiting a planet. This activity gives students the opportunity to think about what is involved in navigating through uncharted territory in a harsh terrain.

Running the Activity

Explain to the children that the ExoMars rover combines human and machine, working together. The rover has to work autonomously on Mars but Mission Control need to be able to monitor and regulate its work from Earth. Show the children a detailed diagram of the ExoMars rover (see Useful Links), looking at its design and features including how it moves on challenging terrain and communicates with Earth.

Set up a short assault course (in the hall if available). Split the children into pairs (blindfolding one person). Take it in turns to act as the controller and the rover. Alternatively in the classroom, children could explain simple tasks – like a drawing a simple pattern – to a blindfolded partner. Discuss with the children how easy or difficult is it to control something remotely.

Questions for the Class

- How can the rover communicate with Earth?
- What features of the ExoMars rover's design enables it to function on Mars?
- How does it navigate the difficult rocky terrain?
- How does Mission Control guide the ExoMars rover?

Additional Challenges / Extension Activities

Design your own maze for a partner to complete.

Use a Qbot or roamer. Create a maze or course and program the roamer to complete it. Alternatively, use Purple Mash (where available) to design a 3D interactive maze to complete on screen.

Write a diary entry 'A day in the life of the ExoMars rover'.

Make a 3D Martian landscape including model ExoMars rover.

Ideas for Differentiation

Lower:

- Describe the journey in terms of turns

Upper:

- Describe using compass points
- Introduce grid references to describe journey through the maze

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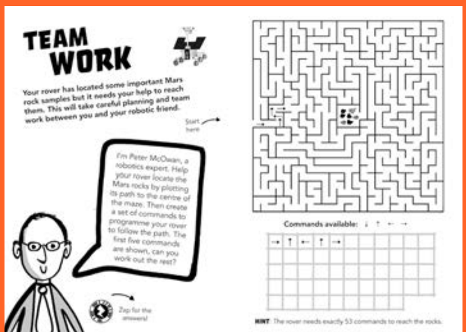

Useful Links

Zappar Content: Download or view the Zappar content for this activity on its webpage (URL to the left) or access it via the Zap.

Diagram of the ExoMars rover https://www.youtube.com/watch?v=6C1V1JHH0J0

Article about Tim Peake controlling 'Bridget' the rover: http://www.esa.int/ESA_in_your_country/United_Kingdom/ESA_astronaut_Tim_Peake_controls_rover_from_space

Clip of Tim guiding rover through obstacle test site from the ISS: https://www.youtube.com/watch?v=vzxndYrQ_U8

Clip about ExoMars testing site in Stevenage: https://www.youtube.com/watch?v=wx9VrZDnWag

ZAP! Students can independently access multimedia resources using the Zappar mobile/tablet app. See Zappar instructions at the link below and note that the mobile/tablet will need to be on a WIFI connection: marsdiary.org/resources/#teacher-toolkit

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Your Mission MARS DIARY

ACTIVITY 4.2
ROVER'S DISCOVERY

From the Chapter Four of the Mission Mars Diary

marsdiary.org/activities/rovers-discovery

LEARNING LEVEL

KS2, P5-7, Y4-6

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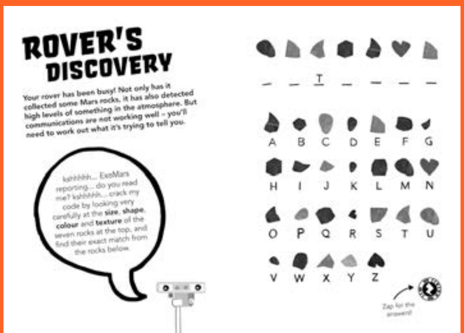

Resources Required

- Smartphone or device for Zap code (optional – see Useful Links)
- Images from the ExoMars rover
- Access to outdoor area to collect rock samples (optional)
- Laptops to research and collate evidence (optional)

Background to this Activity

This activity uses the premise of rock samples collected by the ExoMars rover to help students practise their visual differentiation skills to crack the code. It also provides an opportunity for students to consider the differences between robotic and human exploration. What are the strengths and weaknesses of the two different types of explorer – and how could they best work together on the surface of Mars?

The ExoMars mission is a true collaboration between humans and robots. Robots like the ExoMars rover can withstand conditions on Mars more easily than humans, because they do not need oxygen, food or the same level of protection against radiation like us. They can refuel themselves with solar panels and do not have the psychological or emotional needs of a human, so exploring Mars alone for a long period of time is not an issue. But robots do not possess the same kind of intuition as humans. The ExoMars rover will be guided by humans to collect the most scientifically useful rock samples, so that we can discover whether there is – or was – life on Mars.

Running the Activity

In this activity the children will crack a code from Mars.

Explain to the children that the job of the ExoMars rover is to collect data to send to Earth so we can develop our understanding of the solar system. Look at some of the images and findings that have been sent back to Earth by the previous Mars missions. Explore what scientists have learnt.

Tell the children that the rover communicates its messages to Earth, which are received by Mission Control. Once the information has arrived it is a human's job to access and analyse the data.

One aspect of this close relationship between human and machine is that the controller needs to interpret the data sent by the ExoMars rover. Introduce the code cracking activity.

Solution to this Activity

METHANE

Questions for the Class

- How are messages from the ExoMars rover received?
- Are the rocks on Mars the same as those on Earth?
- Why do you think it is important to collect samples from planets like Mars?
- Can you investigate/research the most significant finds from expeditions to Mars?
- What do you think are the benefits and challenges of the close relationship between human and machine?

Additional Challenges / Extension Activities

Create your own message from the code to test a friend. Ensure the word is connected to Mars (e.g. rover, Olympus Mons etc.).

Look for Earth rocks outside. Photograph them and assign letters. Spell out words in the rocks for the class to solve.

Research. Find out why methane is the solution to the code. Investigate the discoveries that have been made on Mars. Collate these ideas into a poster or PowerPoint presentation.

These ideas could be combined in a display.

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LEARNING LEVEL

KS2, P5-7, Y4-6

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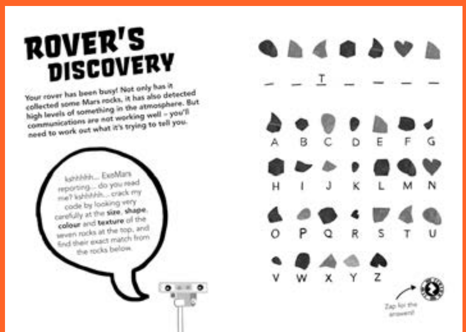

Ideas for Differentiation

Lower:

- Add further letters to the completed code before the children start.

Upper:

- Number the letters (A=1, B=2 etc). Children will then match the number to a letter and discover its place in the code.
- Develop a similar code based on rock samples. Children can draw their own rock samples for each letter of the alphabet and create words for others to solve.

Useful Links

Zappar Content: Download or view the Zappar content for this activity on its webpage (URL to the left) or access it via the Zap.

Clip made on the third anniversary of Curiosity's launch (2015) which shows how humans control the rover from Earth (includes good footage of Martian landscape and rover in action): https://www.youtube.com/watch?v=Txti0XLxOzI

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zappar GET ZAPPAR ZAP THE CODE

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ACTIVITY 4.3
MARTIAN MECHANICS

From the Chapter Four of the Mission Mars Diary
marsdiary.org/activities/martian-mechanics

LEARNING LEVEL

KS2, P5-7, Y4-6

CURRICULUM LINKS & DIFFERENTIATION IDEAS

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marsdiary.org/resources/#teacher-toolkit

Resources Required

- Smartphone or device for Zap code (optional – see Useful Links)
- Loose parts and materials that would allow the pupils to explore the 'space mechanics toolkit' and how the elements work

Background to this Activity

Although the ExoMars rover will use its built-in instruments to analyse samples, this activity asks students to create a machine to get their rock samples back to an astronaut on Mars. This creative and technical challenge asks students to think about how they would resolve this problem. With inspiration from real-life structural building toys, students will have to construct a machine to bring their rover over a mountain. This is an ideal way to introduce students to forces, structures and machinery.

Running the Activity

Provide resources so that children can explore the 'space mechanics toolkit' prior to designing their machine.

Lower ability pupils may find it more useful to go on a 'mechanics' hunt around school, looking for places where gears, levers, pulleys etc are in everyday use. They can bring this knowledge back to share with their peers in class, collecting evidence using photographs and sketches.

It may be preferable to design a machine in a large group (even as a whole class) initially. Then allow the pupils to redesign it to make it 'better', or lower ability children can copy it and verbally explain to their peers and classroom adults how it would work.

Questions for the Class

- Why is it important to analyse rock samples from different places in Mars?
- Why would you need to bring the rover over the mountain, rather than around it?
- What do you think the rover will be bringing back to you? What might the scientific analysis of the rocks tell you?
- What machines do we use for lifting objects on Earth?

Additional Challenges / Extension Activities

Consider what might happen if Mount Sharp was a different height or shape.

Create a more technical drawing of your machine, fully labelled.

What materials would you make your machine from? Research different materials you would need and why they would be the best.

Ideas for Differentiation

Lower:

- Spend a greater amount of time creating a lifting machine using construction resources and exploring the properties of the different mechanics and materials.

Upper:

- Support pupils to accurately produce a scale drawing or model, using appropriate measurements.
- Encourage exploration of different methods of lifting and which would be most appropriate for Mars.

Useful Links

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Your Mission MARS DIARY

ACTIVITY 4.3 MARTIAN MECHANICS

From the Chapter Four of the Mission Mars Diary

marsdiary.org/activities/martian-mechanics

LEARNING LEVEL

KS2, P5-7, Y4-6

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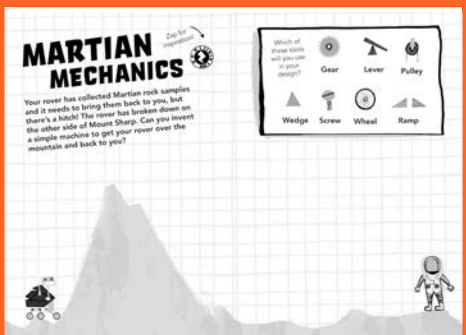

Your Mission MARS DIARY

ACTIVITY 4.4
SPACE LAB

From the Chapter Four of the Mission Mars Diary

marsdiary.org/activities/space-lab

LEARNING LEVEL

KS2, P5-7, Y4-6

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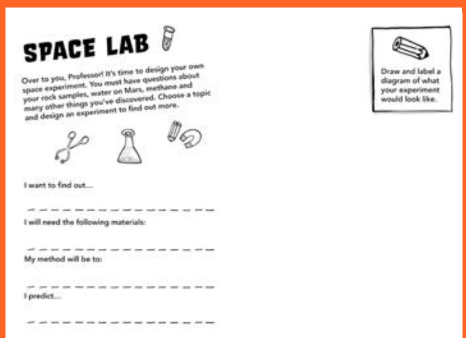

Resources Required

- There are plenty of video and internet resources that can provide children with additional information about the presence of methane on Mars. This link https://www.youtube.com/watch?v=-0K1jkLZiZQ from Space@Nasa provides child-friendly information of methane on Earth and Mars if children have not completed previous activities.
- Workbook
- Drawing equipment

Background to this Activity

Designing an experiment to test a hypothesis is a fundamental part of scientific enquiry. This chapter builds up to this concluding challenge by laying the foundations for students to investigate the presence of methane on Mars. To finish this chapter, they must consider how they find out where – or whom – it was coming from!

Methane is an organic molecule present in gaseous form in Earth's atmosphere. More than 90% of methane on Earth is produced by living organisms. Methane has already been detected on Mars, which is why scientists believe that there may be alien life on the Red Planet. But methane can be produced in more than one way. On Earth, scientists discovered microbial life living 2-3 kilometres beneath the surface of the Witwastersrand basin in South Africa. These microbes produced methane. If similar microbes lived beneath the Martian surface, it would explain the presence of methane on Mars. Alternatively, the methane could have been produced by microbes which lived on Mars millions of years ago, and is being released into the atmosphere today as the surface temperature and pressure changes, which would indicate that there was once life on Mars.

But methane can also be produced inorganically or geologically, by hot springs or volcanoes, and this does not indicate that life once existed. The methane may have been produced millions of years ago but was trapped below the surface for a long time. Certain chemical reactions are possibly taking place under the Martian surface to produce methane, which is then released into the atmosphere.

Confirming the presence of methane on Mars is one of the goals of the ExoMars Mission. The ExoMars Trace Gas Orbiter, which was launched on 14 March 2016 and reached Mars seven months later, is measuring and mapping methane and other gases on Mars. When the ExoMars rover arrives on the Red Planet in 2020, it will look for signs of life by drilling into Martian rock. This will help scientists discover whether the methane has been produced biologically or geologically.

Researchers propose three hypotheses to explain observed methane peaks of seven parts per billion measured by the Curiosity rover in Gale Crater, which is 10 times higher than background values. The neat thing is that the hypotheses are testable.

The first hypothesis suggests that the soil in Gale Crater absorbs methane when dry and releases it to the atmosphere when the relative humidity in the Martian soil is high enough for perchlorate salts to attract water vapour from the atmosphere and dissolve in that water. The second hypothesis – the most exciting one – suggests that microbial life on Mars is the cause, and that microorganisms convert organic matter in the soil to methane when the microbes are in liquid solutions. The third hypothesis is that the bursts of methane are produced by deep subsurface aquifers.

Fortunately, the Curiosity rover should be able to find out which explanation is the most likely one. If either of the first two hypotheses are right, the methane variability is seasonal and should repeat every year. The methane abundance should peak in early winter if it's due to inorganic adsorption; if it's biological in origin, it should peak in late winter. And sporadic spikes would favour

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marsdiary.org/activities/space-lab

LEARNING LEVEL

KS2, P5-7, Y4-6

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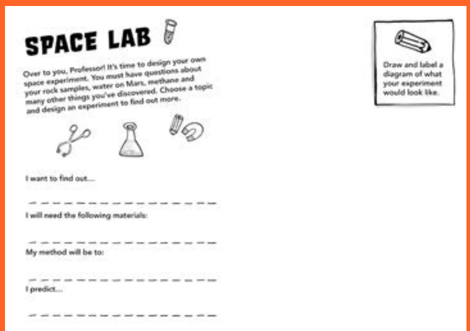

the third hypothesis. Of course, there could be other explanations not considered by the authors.

Running the Activity

Ensure that children understand that scientists have already proved the presence of methane on Mars.

Discuss – with appropriate video resources – the different hypotheses about where the methane is coming from on Mars.

Allow children time to discuss in pairs/small groups how they would go about investigating where the gas is coming from.

Give children time to share their ideas – this could be done using think/pair/share or by selecting individuals to explain their ideas to the class.

Remind children of the three hypotheses and ensure they can match a prediction to their experiment.

Give time to complete the planning sheet – children should be encouraged to label their diagram and be able to explain their experiment.

Questions for the Class

- How is methane produced on Earth?
- How have scientists concluded that methane is present on Mars?
- Where do scientists think the methane on Mars is coming from?
- How do scientists plan to investigate where the methane on Mars is coming from once ExoMars arrives in 2010?
- What conclusions can be drawn from the fact that there is methane on Mars?

Additional Challenges / Extension Activities

When working scientifically, more able pupils should be given the opportunity to work more independently to draw their own conclusions.

These pupils could be given time to research any of the following aspects in order to better understand the scientific process:

- How scientists plan to investigate methane using ExoMars
- The ecological problems caused by methane on Earth
- The type of data gathered by space probes and rovers
- How space probes and rovers communicate with centres back on Earth
- Other space probes and rovers

Ideas for Differentiation

Lower:

Some children will need additional support and may benefit from being placed in adult-supported groups when discussing initial ideas.

Children could be given a series of options from which they could select the most appropriate when designing their own experiment.

Some children, who may struggle to design their own experiment, could be given a series of planned experiments alongside explanations of the three hypotheses of where the methane is coming from. They would then match up the experiments and the hypotheses and explain their reasoning.

Upper:

More able pupils may benefit from forming groups with equally able children with whom they can discuss more complex ideas when designing their experiment.

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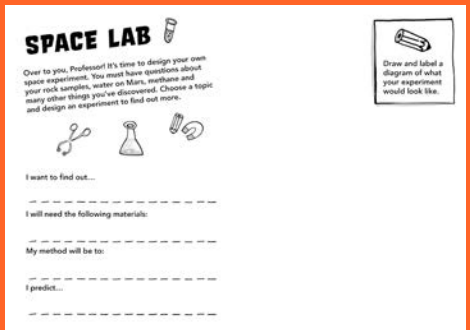

Useful Links

The filmed interview with John Grotzinger – a Curiosity project scientist – that appears in this article (published in 2014) about the research conducted by NASA's Curiosity rover, explains why methane is of interest to scientists, and what future missions (i.e. ExoMars) might do: https://www.space.com/28019-mars-methane-disovery-curiosity-rover.html

ESA clip from 2016 explaining how the ExoMars mission will research the presence of methane. Please note that the year given for the rover's arrival in this clip is 2018, however the rover will now arrive on Mars in 2020. This clip includes an animation of the rover collecting rock samples: https://www.youtube.com/watch?v=SvKUe_q0ZC4

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