Space

Students will produce a project journal to help in the design of a water resourced space station on Mars. The Colony will need a great deal of water for many purposes, including drinking, washing, and growing food. This will determine the resources required to ensure the viability of a space settlement.

Subject area:

Science

Year level:

Year 7

Learning objectives:

- Some of Earth's resources are renewable but others are non-renewable
- Water is a precious resource that cycles through the environment
- Essential resources influence the liveability of a place
- Understanding factors influencing liveability
- Apply understanding of liability to design own 'Planet B'

Curriculum links

Earth and space science	ACSSU116
Nature and development of science	ACSHE119
Earth and space science	ACSSU222

Cross-curriculum priorities: Sustainability

OI.1	The biosphere is a dynamic system providing conditions that sustain life on Earth.
OI.3	Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.
OI.4	World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice, are essential for achieving sustainability.
OI.7	Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.

General capabilities

Literacy

Critical and creative thinking

Personal and social capability

Information and communication technology (ICT) capability

Ethical understanding

WATER CORPORATION

What would it be like to stand on Mars?

One day in the future, with our intervention, Mars could potentially be the next Earth. Students will watch a video by V101 Science about NASA's plans to inhabit the planet, and answer questions on their comprehension page.

Time required:

1 hour

Resources required:

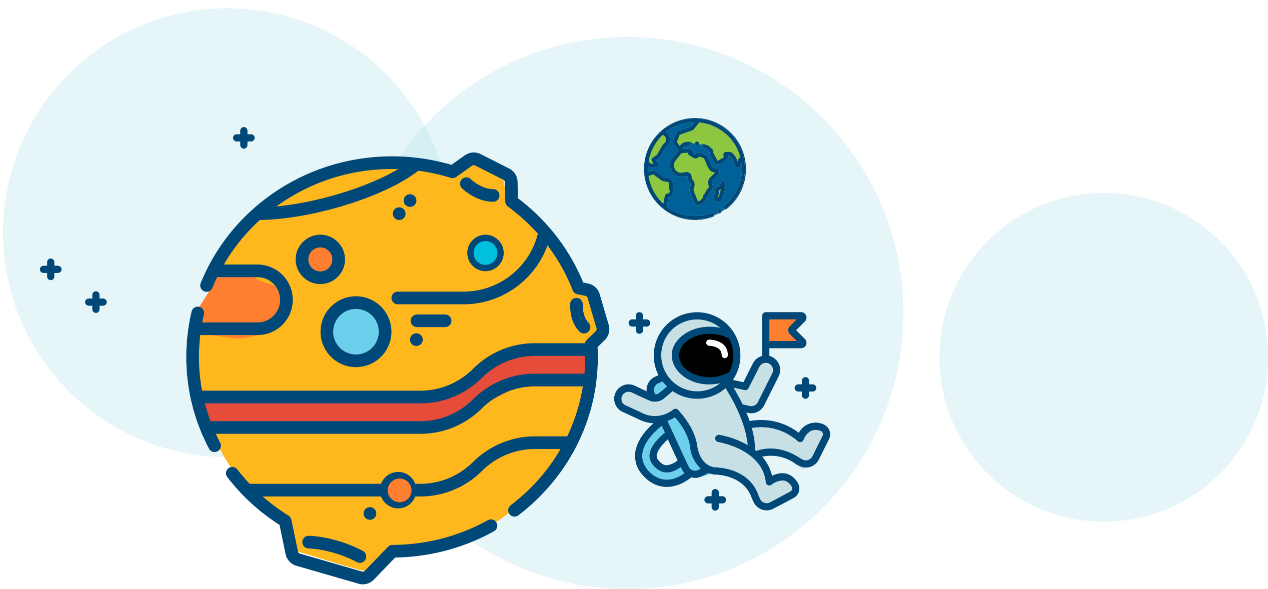
- **ipad or computer per student**
- **Activity page 1: What would it be like to stand on Mars?**

Preparation:

1. Ensure students have access to video What would it be like to stand on Mars?
2. Print activity page 1: What would it be like to stand on Mars?

Steps:

1. Watch the video What would it be like to stand on Mars?
2. Facilitate discussion by asking students as a group:
   a. What does the landscape of Mars resemble?
   b. What blankets the planet's surface?
   c. What would visibility be like on Mars? What would impact this?
   d. Describe the temperatures on Mars. Are they similar to Earth?
   e. Describe the atmosphere on Mars. How would this impact us visiting?
3. Following the class discussion, students are to spend time completing activity page 1: What would it be like to stand on Mars?



Wastewater recovery system

Students will build and test a simulated wastewater recovery system to create purified water for their mission to Mars. Students measure the effectiveness of their filtration device using pH test strips.

Time required:

1 hour

Resources required:

- **Activity page 2: Conductivity tester**
- **Activity page 3: Wastewater recovery system**

Each group:

- **2 x 500mL plastic water bottles**
- **1 x pair of scissors**
- **1 square of 10cm x 10cm muslin cloth**
- **2 rubber bands**
- **1 x measuring cylinder**
- **1 x digital scales or weight balances for weighing filter media**
- **A variety of mixed materials to choose as filter media: cotton balls, wadding/bumf, aquarium gravel, uncooked macaroni, rice (washed clear), activated carbon (rinsed), play sand, coffee filters,**
- **1 litre of simulated wastewater (instructions in preparation)**
- **Conductivity tester per group**
- **4 x pH indicator strips**
- **Multimeter with 2 plug in leads, both with a metal tip**
- **1 battery (9 volt)**
- **1 battery connector for a 9 volt battery**

Preparation:

1. Begin collecting matching 0.5 L bottles in advance of this activity to save the cost of purchasing them.
2. Build (or have students build) and test conductivity testers prior to experiment. Activity page 2: Conductivity tester.
3. Print activity page 3: Wastewater recovery system for students to follow instructions to make their filtration device and conduct experiment..
4. Be sure to rinse and thoroughly dry activate carbon (if using). Un-rinsed carbon will turn the water black.
5. Consider assigning roles to team members, such as Speaker, Manager, Director, and Recorder.
6. Mix up simulated wastewater in advance of the activity. To make approximately four litres of simulated wastewater:
    a. Mix two cups of distilled vinegar, several drops of yellow food colour, a handful of human hair from someone's hairbrush, dust swept from the floor, half a cup of topsoil or sand (bought from shop to reduce other pollutants entering water) and enough water to make up to four litres.

Steps:

1. Discuss with students the importance for space shuttles to save and recycle water to ensure they have enough to last the mission.
2. Students will spend this lesson and possibly the next, designing an effective water recovery system. The effectiveness of the system will be checked with a pH conductivity test.
3. Spend time observing the simulated wastewater and allow students to use the wafting technique to record the odour of the mixture.
4. As students will be recording the pH of their wastewater, spend time:
    a. practicing the use of the pH test strips
    b. describing the difference between alkaline and base mixtures
    c. comparing the pH of vinegars to bicarbonate soda to their school tap drinking water.
5. Students will also need to become familiar with the safe way to use the conductivity testers. Hand out activity page 2: Conductivity tester. Go through the steps to create a conductivity tester, outlining the importance of staying safe.
6. Explain how the testers will create an electrical circuit through the water in order to measure the conductivity. If there are inorganic materials in the water, the electricity will easily travel through but if the water is pure, the electricity will not travel through and create an electric current. To allow familiarity for students on how to use the tester, prove a few different solutions for them to test and understand how to read the multimeter. Students need to be aware of how to use the conductivity tester safely:
    a. Do not allow the two ends of the tester to touch at any time as this will lead to an overload of electricity and malfunction the multimeter.
    b. The distance leads are from the bottom of the jar and need to be apart from each other as this will affect the reading.
7. As a class, decide on a controlled and consistent distance for measurement, such as 1cm from the bottom of jar and on opposite sides against the wall of the jar.
    a. Gently swish the water in the jar immediately before taking a reading, then count to 10 and record the mA value on the multimeter.
    b. Clean and dry the leads between every test.
8. Students need to think about the filter media they will use for their experiment. Encourage the groups to discuss the order of their materials in the bottle and the measured amounts of each. This will prove useful when they redesign their filter to improve results. Students do not need to use every media provided. They also do not have to use all of a particular media just because they have it, although it is important that the activated carbon be used.
9. Hand out activity page 3: Wastewater recovery system.
10. As a class, go through the steps to making the wastewater filtration device.

Plans for Mars

Students will investigate the possibilities of living on Mars and ideas for the future before designing their own plans to sustain life on the Red planet.

Time required:

1 hour

Resources required:

- **ipad or computer per student**

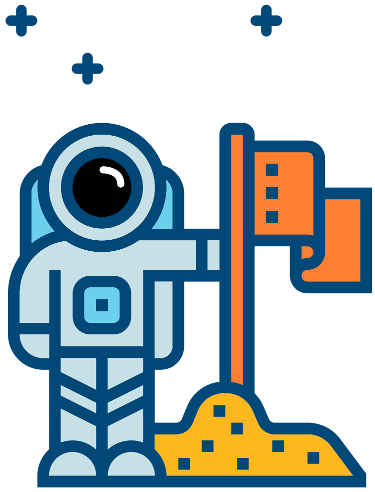
Preparation:

Ensure student access to:

1. Is Mars habitable? With the right technologies, yes
2. Jeff Bezos plan for colonizing space
3. NASA's 'Treasure Map' of water ice on Mars
4. Google drawings

Steps:

1. Locate information about the natural resources found on Mars from reading Is Mars habitable? With the right technologies, yes.
2. Watch Jeff Bezos plan for colonizing space by Tech Insider.
3. Investigate NASA's 'Treasure Map' of water ice on Mars to determine possible Mars colony landing sites and why they would be most suitable.
4. Investigate potential sources of water like the polar caps composed of water-ice and CO2 dry ice, and water-ice existing a few metres under the surface regolith.
5. Design and draw water infrastructure plans for a Mars space station. Utilising knowledge of water filtration systems, research and include the most recent technological advances for obtaining and purifying the most precious of resources essential for maintaining life on Mars.
6. Use Google Drawings to present final drawings to share with class.



What would it be like to stand on Mars?

The Red Planet is millions of miles away from us, but hopefully one day we will be visiting Mars for our holidays?. View V101 Science YouTube clip <u>What would it be like to stand on Mars?</u> and answer the following questions about the fourth planet from the sun.

1. How far away from the sun will you find the Mars?

2. What year has NASA set to make their first rocket launch to Mars?

3. What will the first astronauts to visit Mars see when they view the landscape?

4. What volcano will they see?

5. Describe what will impact visibility on Mars?

6. What temperatures will the astronauts experience on the Red Planet?

7. Describe what the astronauts will see when they become visible in the night sky.

8. What is the atmosphere like on Mars?

9. What do humans need to live away from the Earth?

10. What would you need to survive on Mars?

Conductivity tester

Follow the steps below to make your own conductivity tester. This will be used to test the conductivity of water filtered through your simulated wastewater recovery system.

Background

A ***conductivity tester*** measures the amount of electrical current in a solution. ***Conductivity*** is useful in determining the overall health of a natural water body. It is also a way to measure changes in wastewater procedures at water treatment plants. ***Conductivity meters*** are common in any water treatment or monitoring situation, as well as in environmental laboratories.

Conductivity is the electrical current in a solution, but that value depends on the liquid's ***ionic strength***. It also relies on which ions are present and their concentration and form, such as what state of oxidation or mobility the ions are in. Ions carry a negative or positive electrical charge. **Anions** are negative and **cations** are positive. In natural water bodies, the ions that contribute to high conductivity result from dissolved minerals and salts.

Follow the steps below to make your own conductivity tester. This will be used to test the conductivity of water filtered through your simulated wastewater recovery system.

Resources required:

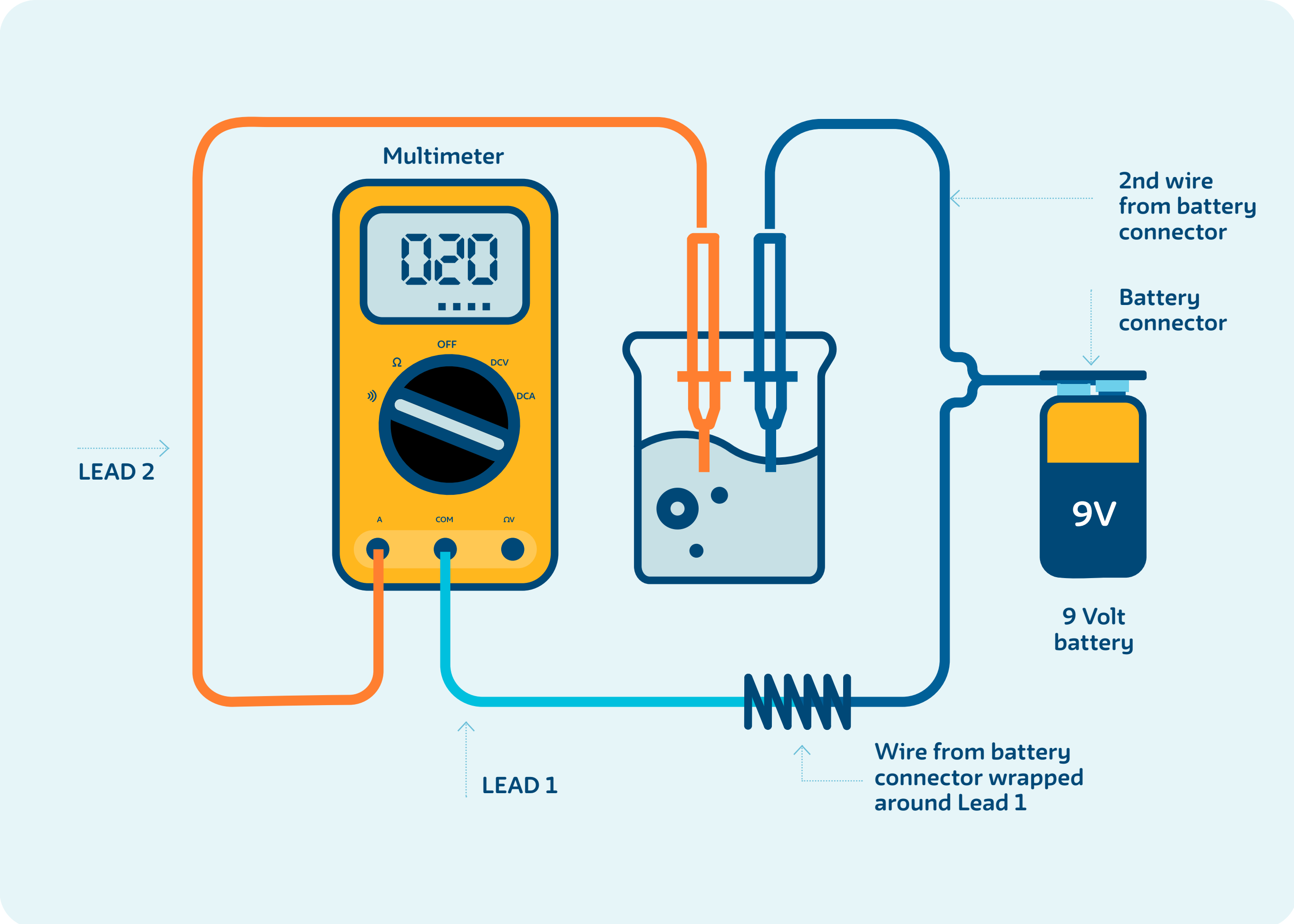
For each group of students:

- **1 multi-meter with 2 plug-in leads, both with a metal tip**
- **1 battery (9 volt)**
- **1 battery snap connector for a 9-volt battery**

Steps:

1. Insert one plug-in lead into the slot labelled COM of the multi-meter, and the other lead into the slot marked A. It does not matter which colour lead goes into which slot.
2. Using one of the wires from the battery snap connector, twist the wire around the metal end of the lead inserted into the slot labelled COM.
3. Clip the battery connector over both terminals of the 9-volt battery. NOTE: Do not allow the loose battery snap connector wire to touch the metal part of the lead inserted into the slot labelled A.
4. Turn the dial on the multimeter to the section labelled A or DCA. Set the dial to 200 m or 200 mA, depending on the labelling of your multimeter.
5. Slightly submerge the exposed wire from the battery snap connector and the lead inserted in the meter slot labelled A in the tester solution. NOTE: Keep the wire and meter lead against opposite sides of the container to avoid them touching.

Activity page 2: Conductivity tester



Assembling the conductivity tester. This will test the conductivity of water filtered through a simulated wastewater recovery system.

Wastewater recovery system

Follow the steps to design and test your own wastewater recovery system. Your aim is to filter the purest water. This will be determined with the lowest conductivity reading using a conductivity tester.

Background:

A wastewater recovery system provides clean water by capturing all the wastewater (including water from urine, hand wash, and oral hygiene waters) cabin humidity condensate and extravehicular activity (EVA) wastes. The recovered water must meet strict standards before it can be used to support crew and other activities.

The system is designed to recycle crewmember urine and wastewater for reuse as clean water. By doing so, the wastewater recovery system reduces the net mass of water and consumables that would need to be launched from Earth to support six crewmembers by 2,760 kg (6,000 lbs) per year. The purity of product water is checked by electrical conductivity sensors (the conductivity of water is increased by the presence of typical contaminants). Unacceptable water is reprocessed, and clean water is sent to a storage tank, ready for use by the crew.

Investigation:

Design an effective wastewater filtration device using two 500mL water bottles. The challenge is to choose the most effective filtering media to achieve the most purified water.

Note: Do not drink this water as the filter will remove some impurities but not enough to be safe enough to drink.

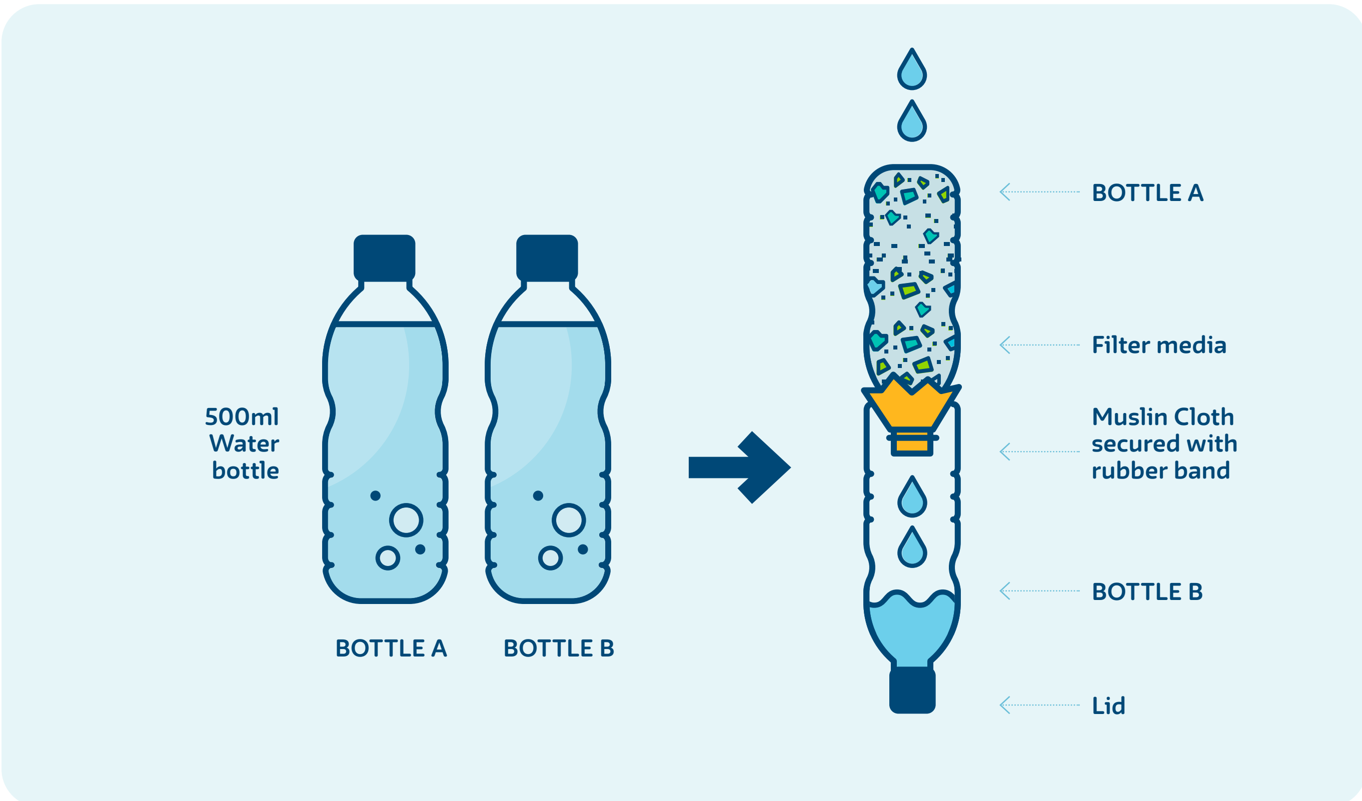
Equipment per group:

- **2 x 500mL plastic water bottles**
- **1 x pair of scissors**
- **1 square of 10cm x 10cm muslin cloth**
- **2 rubber bands**
- **1 x measuring cylinder**
- **1 x digital scales or weight balances for weighing filter media**
- **A variety of mixed materials to choose as filter media: cotton balls, wadding/bumf, aquarium gravel, uncooked macaroni, rice (washed clear), activated carbon (rinsed), play sand, coffee filters,**
- **1 litre of simulated wastewater**
- **Conductivity tester per group**
- **4 x pH indicator strips**

Procedure:

1. Allow about 10 minutes to prepare two water bottles for the filtration device. The filtration device is made from two 500mL water bottles (A and B) with the bottoms cut off.
2. Remove the lid off one of the bottles (A) and place a square of muslin cloth over this bottle neck securing with a rubber band. Ensure lid is securely fastened to bottle B.
3. Place the neck of bottle A inside the open base of bottle B stacked so as to allow the wastewater to filter through one bottle and collect in the second.
4. Spend time choosing various filter media to place in bottle A. Allow time to measure, place media in bottle A to 4cm from the open top and record the sequence of amounts.
5. Once the filter media has been added, you may prefer to tape the bottles together to help alleviate toppling otherwise stabilise by using ring stands and clamps.
6. Measure 200ml and record the pH and conductivity of the simulated wastewater.
7. Gently pour the 200ml of simulated wastewater through the water filter.
8. Observe the results of the filtered water. Spend time re-testing pH, conductivity, and then describe odour and colour of water.

Wastewater Recovery System



Activity page 3: Wastewater recovery system

1. What is the problem or challenge to be investigated?

2. State the variables for the experiment:

Independent variable **What will I change?**	**Dependent variable** **What will I measure?**	**Controlled variables** **What will I keep the same?**

3. List the equipment chosen for your wastewater filtration system.

4. Make a prediction about the results of your wastewater recovery system and explain why you think this will happen.

Activity page 3: Wastewater recovery system

5. Draw a labelled diagram of the equipment set up.

6. Write the method you used to conduct this experiment.

7. Design a table for recording investigation results. Label all relevant columns.

8. Scientific knowledge has changed our understanding of the world. How could your wastewater recovery system be used to improve or influence human activity in the future?