OFF-EARTH HABITATS

Recommended for Years 7 to 10

EDUCATOR NOTES

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The Big Question

What would it look like to live off-Earth?

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Mission Objective

Students (individually or in groups) will identify something that is required for life. They will consider how such a need can be facilitated in space by an object or system. They will then design and build a model of their solution that meets their identified need. They will then review and improve their model.

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Images

Above: *A base on Mars, Martian colony in desert.*

Below: *Artist impression of Australia's vision for a lunar base.*

Curriculum Links

Curriculum Links are taken from the Australian Curriculum Version 9, for further information: https://www.australiancurriculum.edu.au/

Subject	Strand	Code	Description
Science Science	Science Understanding	Earth and space sciences AC9S9U03	Represent the carbon cycle and examine how key processes including combustion, photosynthesis and respiration rely on interactions between Earth's spheres (the geosphere, biosphere, hydrosphere and atmosphere)
	Science Understanding	Physical sciences AC9S7U04	Investigate and represent balanced and unbalanced forces, including gravitational force, acting on objects, and relate changes in an object's motion to its mass and the magnitude and direction of forces acting on it
	Science as a human endeavour	Nature and development of science AC9S7H01 AC9S8H01	Explain how new evidence or different perspectives can lead to changes in scientific knowledge
	Science as a human endeavour	Use and influence of science AC9S7H03 AC9S8H03	Examine how proposed scientific responses to contemporary issues may impact on society and explore ethical, environmental, social and economic considerations
	Science as a human endeavour	Use and influence of science AC9S9H04	Examine how the values and needs of society influence the focus of scientific research

Curriculum Links

Subject	Strand	Code	Description
Design and Technologies	Processes and production skills	Investigating and defining AC9TDE8P01 AC9TDE10P01	Analyse needs or opportunities for designing, and investigate and select materials, components, tools, equipment and processes to create designed solutions
	Processes and production skills	Generating and designing AC9TDE8P02 AC9TDE10P02	Generate, test, iterate and communicate design ideas, processes and solutions using technical terms and graphical representation techniques, including using digital tools
	Knowledge and understanding	Technologies and society AC9TDE8K01 AC9TDE10K01	Analyse how people in design and technologies occupations consider ethical and sustainability factors to design and produce products, services and environments

Context

In December 2017, NASA announced the Artemis program, an extraordinary endeavour to put humans back on the Moon, and then further on to Mars.

In October 2020, the Australian Space Agency partnered with NASA in this program by signing the **Artemis Accords**. This is a group of common principles for cooperation between countries in space.

Since the first astronauts went up to the International Space Station in November 2000, humans have had a continuous presence outside of Earth. Humans have never lived for longer than several days on the Moon, and have never lived on another planet.

We now have better knowledge of how the human body reacts to microgravity. As we approach more deep space travel, we now need to consider how humans will live and work on the Moon and Mars.

Your mission is to consider the aspects that enable humans to thrive here on Earth and how we can achieve that on the Moon or Mars.

Three key areas:

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Australia in Space

The cosmos has fascinated humans for millennia. First Nations Australians have been looking up into the sky for 60,000 years and making observations to inform their hunting, gathering, social and navigation practices.

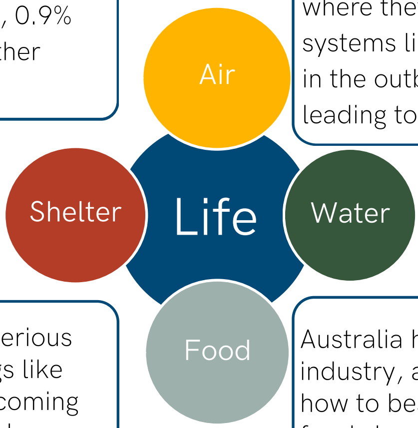
Australia was very active in the early decades of the Space Age. We were one of the first countries to launch our own satellite. Today, Australia's involvement is growing again. We are contributing to part of the Artemis program.
As humanity plans to go to the Moon and then on to Mars, Australia has an important role to play.

Surviving and Thriving Beyond Earth

There are 4 basic needs that humans require to survive:

On Earth, we have a perfect atmosphere that allows us to breathe. It is made of 78% nitrogen, 21% oxygen, 0.9% argon, and 0.1% of other gases.

Australia is very used to surviving in climates with very little water. Whether that is in Antarctica where they use melt lakes or systems like reverse osmosis, or in the outback with bore holes leading to underground lakes.



Earth gives us some serious protections from things like harmful UV radiation coming from the sun. We also have an atmosphere that has our breathable air and helps regulate temperature.

Australia has a large agriculture industry, and we have learned how to best farm and grow foods in unfavourable conditions. This involves growing native species and working with native animals.

We don't just want people to survive, we also want them to thrive:

Sleeping and Eating

- There is less gravity on the Moon and Mars compared to Earth.
- Eating on the ISS is significantly more challenging than on Earth: the lack of gravity makes the way we consume foods different.

Socialising and Recreation

- Mental health matters in the high-stress environment of space. Humans need contact with family and friends, but delays on Mars could make that harder.
- Astronauts will also need new ways to relax without usual activities like movies or sports.

Exercising

- On the ISS astronauts must do 2 hours of exercise every day to retain their muscle mass.
- Even then when they come back to Earth, they must do rehabilitation to regain their original abilities under Earth's gravity.

Hygiene

- Cleanliness is important if we want to stay healthy. The ISS has a filtration and cleaning system that keeps humans away from dangerous waste products.

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Australia has many ways of getting water, by utilising dams, collecting and storing rainwater in large reservoirs, groundwater access by bores, recycled water from our homes that goes through a cleaning process and desalinated water from the ocean.

The desert like areas of Mars are thought to be suited to plants like dandelions, microgreens, lettuce, rocket, spinach, peas, garlic, kale and onions.

Australia is used to facing challenges in construction with the extreme weather here. We also built permanent bases on subantarctic Macquarie Island and three other stations on the Antarctica.

Design Principles

THINK
Select one challenge humans would face living on the Moon or Mars

MAKE
Make a model of your solution, be creative!

TEST
Does this solution work for everyone? Is anyone or anything missing?

IMPROVE
Change or add something to your solution so it helps everyone!

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This design structure can help scaffold the design process for students.

Explain with examples the design principles. E.g.:

Think: How do we breathe in space?

Make: Let's make a helmet that has oxygen in it.

Test: Does this work for people who have a bigger or smaller head than me?

Improve: Add an adjustable head strap so it can be used by multiple people.

Each area of the design process gives you key things to think about and actions to take along each step of your design and creation journey.

Emphasise to students that this is a circular process and that projects often undergo multiple cycles before they are finished.

Emphasise that engineers and designers use an engineering design process to keep their ideas and projects on track

Mission Overview

Aims:

- Students will identify factors that enable life on Earth and that these are necessary for humans to live on another planet.
- Students will identify ways that necessities for life can be replicated in space.
- Students will use design principles to design systems and creatively construct them in models.
- Students will evaluate their solutions, identify things that can be changed and improved and then implement them.

Materials:

- Copies of student hand out
- Writing Utensils
- Recyclable Materials such as shoeboxes, al foil, cling wrap, printed images, paper, paper clips, foam/paper cups/plates/bowls, egg cartons, cereal boxes, milk cartons etc.
- Construction Materials such as: Hot glue, PVA glue, scissors, paint and paint brushes, markers, tape.

Preparation:

- Read through students' pack, and educator notes to familiarise yourself with the activity.
- Decide if students will be working independently or in groups.
- Gather and prepare supplies required.
- If using videos or online resources, test links and technology beforehand.

Mission:

Students (individually or in groups) will identify something that is required for life. They will consider how such a need can be facilitated in space by an object or system. They will then design and build a model of their solution that meets their identified need. They will then review and improve their model.

Notes:

Assess age appropriateness regarding use of scissors, hot glue etc.

Encourage creativity with the materials and how they may have many functions.

Phase 1: Think and Make

Introduce the Mission:

- Explain the challenge to students
- Distribute student handout.
- Explain the design principles and how they help us make things.
- Ask students to identify things that we need to live. Encourage them to look in the student handout for help. A mind-map on the white board may be useful at this stage.
- Once needs have been identified, encourage students/groups to select one and think about what makes it possible on Earth. Ask them to consider if that is something that comes naturally in space or do we need to manufacture it.

Extension Materials:

- Depending on the focus of needs identified, videos regarding technology around energy supply or mining on the moon may be useful, please take a look at this links below and assess if they would be suitable for the class.
    - Mining the Moon
    - Deadly Junk in Space
    - Mars Weather report
    - What are Exoplanets
    - Seeing the light, the future of solar power: Professor Andrew Holmes AC FAA FRS FTSE
    - Better plants, better future
    - Is hydrogen the fuel of the future?
    - Space Communicator Snapshot - Space Sustainability
    - Pizza Night
    - Tennis in space
    - Running in Space!

Students (individually or in groups) will identify something that is required for life. They will consider how such a need can be facilitated in space by an object or system. They will then design and build a model of their solution that meets their identified need.

Extension Questions:

Does this work for all different kinds of bodies? (Many systems in space are not designed for all bodies.)

Is this a sustainable solution? Does it require non-renewable resources?

Does this require you to send things to the colony? Will it be too heavy?

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Phase 1: Think and Make

Facilitate:

- Once students have designed a solution, allow them to access a variety of recyclable materials to physically build their model.
- Encourage them to be creative with materials that they use.
- Extend thinking by asking extension questions as they go.
- Get students to consider sustainability in their building, use only what they need. This can be extended to how these materials would be used in real life and why we need space sustainability.
- Encourage students to observe others designs and discuss them with each other.
- As an optional activity, you can have each student/group present their model to their class, detailing the need they identified, their solution and displaying their model.

Extension Questions:

What kind of real-life materials might you use?

How might this protect you from the weather/ radiation/ extreme temperatures?

Is this easy for a person to use?

Is this comfortable for a person to use?

Phase 2: Test & Improve

Introduce the Mission:

- Emphasize that the design process they have been using is a cycle not a linear process.
- Ask students to review their model, is anything missing?
- Ask them extension questions such as: is this a sustainable solution? Who does this work for and who doesn't it work for? Is this a long-term solution? Where would I get the materials for this from?

Facilitate:

- Allow students time to refine or alter their design.
- Let students go back to the making phase and remake their design, adding or changing what they need.
- Tell students that this is the same type of process that engineers use when making and refining a product or piece of technology.
- When students have finished redesigning and implementing their improvements, allow them to present their new models to each other.
- This could be structured as everyone walking around the room to observe or each student/group presenting to the class. If they presented earlier this is an opportunity to explain what they discovered in their review and what they implemented to accommodate that.

Students (individually or in groups) will review their model solution and evaluate it with extension questions. They will then alter or add on to their initial solution and design to improve it.

Extension Questions:

Who is included in your solution?

Could this be more sustainable?

Is this a long-term solution?

How many people will this work for?

Could we use this on far away planets?