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91922R

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Science 2025

91922 Describe features of science that have contributed to the development of a science idea in a local context

Credits: Five

RESOURCE BOOKLET

Refer to this booklet to answer the questions for Science 91922.

Check that this booklet has pages 2–6 in the correct order and that none of these pages is blank.

YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.

SCIENCE IDEA ONE: Designing spacesuits for the lunar and Martian environments

New Zealand is partnering in global research initiatives by working with the United States' National Aeronautics and Space Administration (NASA) to learn more about the environment, Earth systems, and climate through observation of the Earth [redacted] emphasise safe operations, sustainable resource use, scientific data sharing, and obeying international space law.

In 2024, New Zealand sent six postgraduate students to intern at NASA, which allowed them to gain valuable experience and knowledge to strengthen New Zealand's science and space sectors.

NASA's Artemis campaign, for which the accords are named, aims to explore the Moon for scientific discovery and technological advancement, and to learn how to live and work on another planet as they prepare for human missions to Mars. NASA plans to collaborate with commercial and international partners, such as New Zealand, and establish the first long-term presence on the Moon. The next Artemis mission will send four astronauts around the Moon to test the spacecraft and launch systems to prepare for future Moon landings. The current crew includes the first woman, the first person of colour, and the first international partner (non-American) to fly in a lunar mission.

Designing spacesuits for the environment

Spacesuits are a necessity for exploring the Moon. A spacesuit is much more than a set of clothes astronauts wear when on space walks outside of the spacecraft or on the lunar surface. A fully equipped spacesuit is really a one-person spacecraft. Space-walking astronauts face the risks of radiation, dust, debris, and extreme temperatures. Temperatures on space walks may vary from as cold as –156 °C to as hot as 121 °C in the sunlight. The spacesuits provide the proper pressure for the body and supply astronauts with water to drink and oxygen to breathe. They also protect astronauts from space dust, which may not sound very dangerous, but when a tiny object is moving many times faster than a bullet, it can cause injury.

Early spacesuits (Figure 1) were custom-made to fit each astronaut, but the spacesuits currently under development (Figure 2) aim to fit a broad range of crew members. These spacesuits will be more abrasion-resistant to protect from potential damage from lunar surface dust. This is important as previous missions have found that lunar dust is very sharp.

Helmets

All previous astronauts wore a communications cap, which contained earphones and microphones, under their helmet. The new spacesuit being developed for Artemis and other future missions includes an upgraded audio system in the helmet itself, meaning that the astronaut no longer needs to wear the separate cap.

The helmet that will be worn for Artemis missions will also feature a 'quick-swap' visor that protects against the abrasive dirt of planetary bodies. The helmet for these new spacesuits is also a shape that provides a better view of the ground around the astronaut's feet.

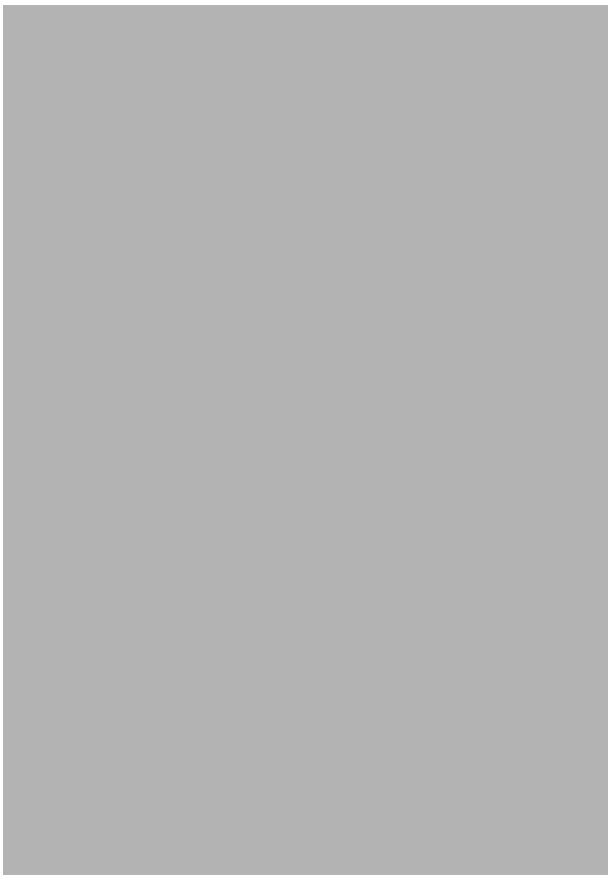

Figure 1: Mercury spacesuit worn by John H. Glenn Jr. in 1962.

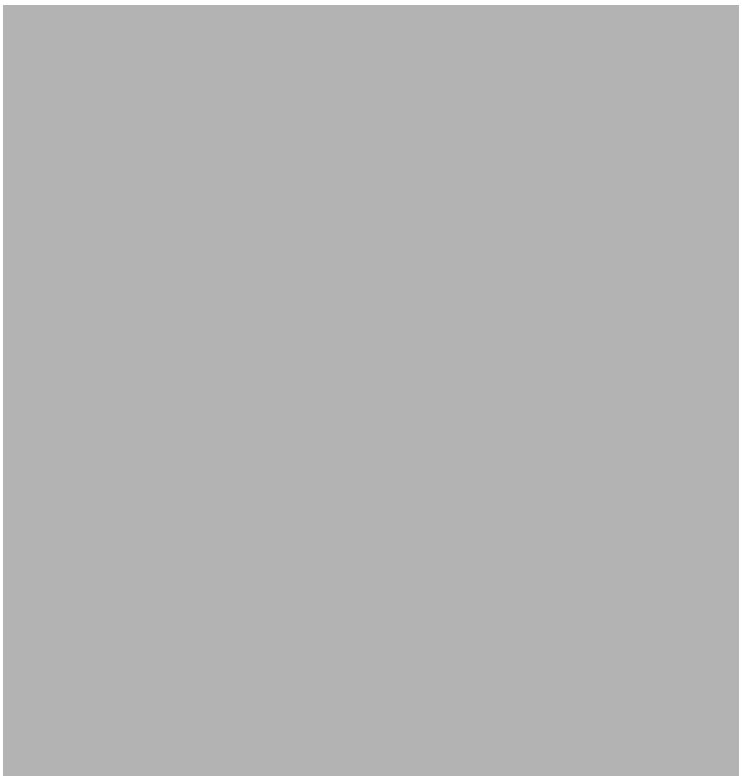

Figure 2: The latest spacesuit intended for the upcoming Artemis III mission to the Moon.

SCIENCE IDEA TWO: Reducing methane production by adding seaweed to cattle feed

New Zealand has around 10 million cattle. These animals play a vital role in the economy, as every year New Zealand exports billions of dollars worth of dairy and beef products. The dairy and beef industries collectively employ over 100,000 New Zealanders, supporting rural communities.

Methane

Methane (CH_4) is one of the greenhouse gases that contributes to climate change by trapping heat in the Earth's atmosphere. Cattle produce methane during the process of enteric fermentation. This is a digestive process in which microorganisms in the rumen (part of the cattle stomach) break down food.

Every year, each cow in New Zealand produces approximately 98 kg of methane, making cattle one of the largest producers of methane in New Zealand.

Scientists are researching ways to reduce methane emissions from cattle.

After several investigations, one promising method for reducing methane emissions from cattle is the use of *Asparagopsis* (Figure 3), a red seaweed native to an area encompassing the South Island, South Australia, and Tasmania. Researchers have found that adding small amounts of *Asparagopsis* to cattle feed can reduce methane emissions, in some cases up to 90 per cent. This is a massive reduction – a cow that usually produces 98 kg of methane per year could emit only 10 kg instead.

Figure 3: *Asparagopsis*

Bromoform

The key compound found in *Asparagopsis* responsible for this reduction is bromoform ($CHBr_3$). The bromoform makes the microorganisms in the rumen stop producing methane, which means that less methane is released into the atmosphere. Later research also found that using the whole seaweed was more effective than using a bromoform supplement on its own.

CH4 Global has set up a seaweed growing facility at the Ocean Beach Aquaculture Hub in Bluff (at the southern tip of the South Island). The seaweed is grown in dozens of huge, aerated tanks (Figure 4), which results in the water having air added to it to help the seaweed to grow. This is important as it allows the seaweed to grow in controlled and optimal conditions at all times, rather than outside in the ocean where the environmental conditions change due to the time of day, tides, weather, and season.

Once the seaweed is harvested, it is frozen, freeze-dried, and sent to another *CH4 Global* facility in South Australia for further processing. This involves adding molasses, to add flavour, and blending and diluting it to get the bromoform concentration desired. The product is then mixed in with the cattle feed, ready for them to eat.

Figure 4: Tanks containing *Asparagopsis* seaweed at *CH4 Global* in Bluff.

What's next

While *Asparagopsis* shows great promise, there are still several challenges that need to be overcome before it can be widely adopted. One major issue is scalability – enough seaweed would need to be grown to supply both the dairy and beef industries, which would require significant resources and investment.

Scientists are also investigating potential long-term effects on cattle health and whether the bromoform in *Asparagopsis* could have any unintended environmental consequences. Research is also ongoing to develop cost-effective ways to integrate seaweed into standard farming practices. Despite these challenges, the use of *Asparagopsis* represents a major step forward in reducing agricultural methane emissions.

Acknowledgements

Material from the following sources has been adapted for use in this assessment:

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