MACMILLAN WALL CHARTS

Space Frontiers

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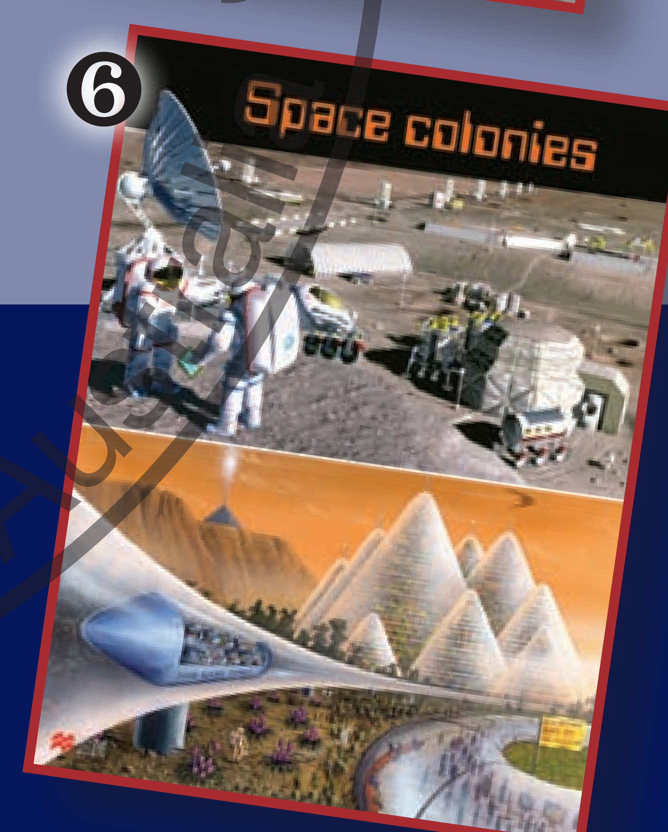

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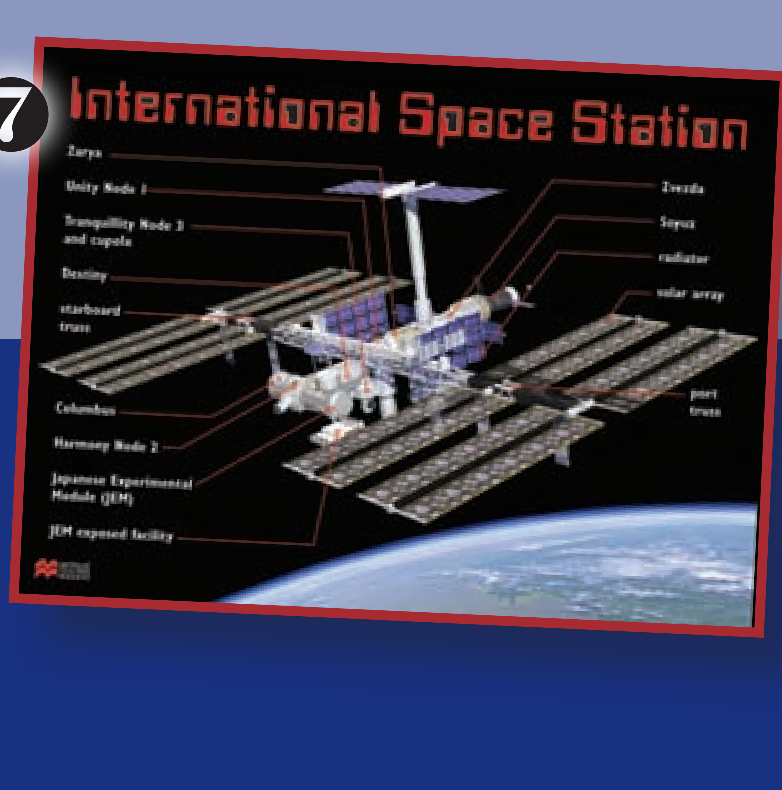

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MACMILLAN TEACHER RESOURCES

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Hints for using *Macmillan Wall Charts: Space Frontiers* in the classroom

The Wall Charts can be a valuable classroom resource to:

- provide a stimulus for discussion and research about space
- provide background information that covers a range of themes about space frontiers including the history of space travel and space inventions
- inspire critical thinking, analysis and reflection.

The charts can be used with individual students, small groups or the whole class and can be displayed individually or as a set, as appropriate.

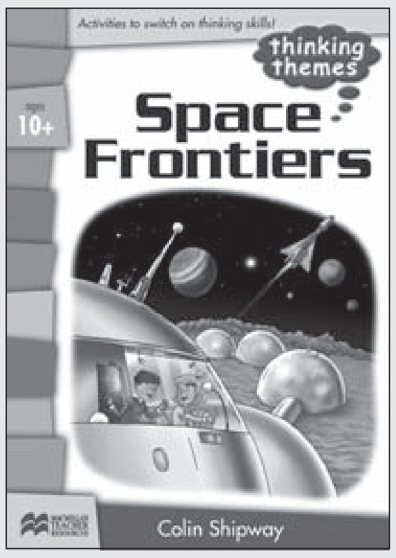
Display the front of the chart to students. Ask what they can observe on the chart. Ask them to make inferences about what is displayed, what they think is happening. Read the background information to the class.

Use the questions listed to stimulate further discussion, or allocate the questions to students for research. The questions are organised under thinking skill headings so that teachers can foster higher order thinking in the classroom. Students might also create their own research questions or devise their own areas of inquiry. Provide time for sharing research information and for further discussion and inquiry.

Note on the use of the term Russia

These Wall Charts use the term Russia. Students will need to be aware, when undertaking research, that between 1922 and 1991 the political entity now known as Russia referred to itself as the Soviet Union, United Soviet Socialist Republic or USSR. This includes the period of time relating to the space race.

Also available:



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ISBN: 978 1 4202 7337 3
Space Science
ISBN: 978 1 4202 7336 6

Background to chart—gives a brief description of each image on the Wall Chart, plus any relevant information.


SPACE FRONTIERS Chart 2

Living in space: Food

Background to chart

Clockwise from top left: An astronaut sampling a beverage during a food evaluation session; astronauts and cosmonauts from three different crews sharing a meal on board the International Space Station (ISS); an astronaut watching a spoonful of food float freely while eating a meal; an astronaut preparing to eat a meal at the galley on board space shuttle *Discovery*; an astronaut eating an apple on board the ISS.

Astronauts eat three meals a day in space. The physical act of eating does not depend on gravity, so chewing food and swallowing is the same in space as it is on Earth.

Astronauts usually eat off special trays attached to a wall or to their lap. (You can see the Velcro straps that hold the tray on the trousers in the photo top left.) Astronauts use knives, forks and spoons but also need scissors to cut packages open. Drinks need to be taken through straws or the liquid would float away.

Most food in space will have been frozen or thermostabilised. Thermostabilisation is a process that uses heat to kill any germs that might make the food rot. Drinks are usually rehydrated. There are no refrigerators on spaceships, so fresh fruit and vegetables are usually eaten during the first few days, although a new process has been developed to protect fresh items from rotting. Meat is irradiated to sterilise it and prevent spoilage.

Dried food, such as a macaroni and cheese meal, is prepared by adding water. Food can be cooked in a convection oven. Salt and pepper are in a liquid form for safety. Food that makes crumbs, for example bread, is not allowed on a spacecraft because the small particles can damage equipment and be dangerous to astronauts.

Key ideas

- Astronauts need nutritionally balanced food to stay healthy in space.
- Technology in food preservation, packaging, preparation and storage has evolved since the early days of space travel to provide astronauts with a wide variety of appetising and healthy food on space missions.

ACKNOWLEDGEMENTS

(Astronaut sampling a beverage: NASA/courtesy of nasaimages.org
Astronauts and cosmonauts share a meal: NASA/courtesy of nasaimages.org
Astronaut watching a spoonful float: NASA/courtesy of nasaimages.org
Astronaut preparing to eat a meal: NASA/courtesy of nasaimages.org
Astronaut eating an apple: NASA/courtesy of nasaimages.org

Questions

Observing
- Describe things in the background of each photo. What equipment, posters, signs, clothing, do you see?

Comprehending
- What are some of the difficulties about eating in space?
- Why are foods which produce crumbs banned on a space mission?

Applying
- What foods do you have at home that might have been developed for space?
- Which foods produce crumbs or fine grains and would be banned on a space mission?

Analysing
- What are the special issues relating to food in space? Why?
- Describe how food is prepared for space.

Reflecting
- What do you think is the worst thing about eating in space? Why?
- How do you think the astronauts in the photos might feel about meals in space?

Evaluating
- Do you think your favourite food would be available on a space station? Explain.
- Is taste or nutritional value more important for astronauts? Explain your opinion.

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Questions—lists questions for you to ask students. The questions are designed to support and facilitate the following thinking skills:

- Observing
- Comprehending
- Applying
- Analysing
- Reflecting
- Evaluating

Key ideas—provides a few brief statements that sum up the key ideas covered by the images.

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Space race

1969

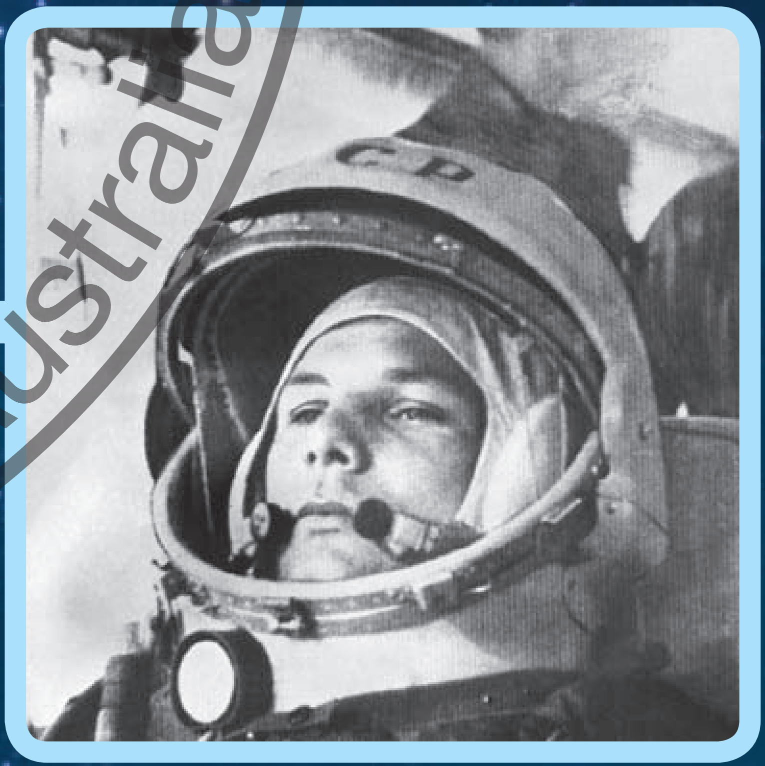
Name: Neil Armstrong and Edwin 'Buzz' Aldrin (pictured)
Country: North America
Spacecraft: *Apollo 11*
Famous for: first humans on the Moon

1963

Name: Valentina Tereshkova
Country: Russia
Spacecraft: *Vostok 6*
Famous for: first woman in space

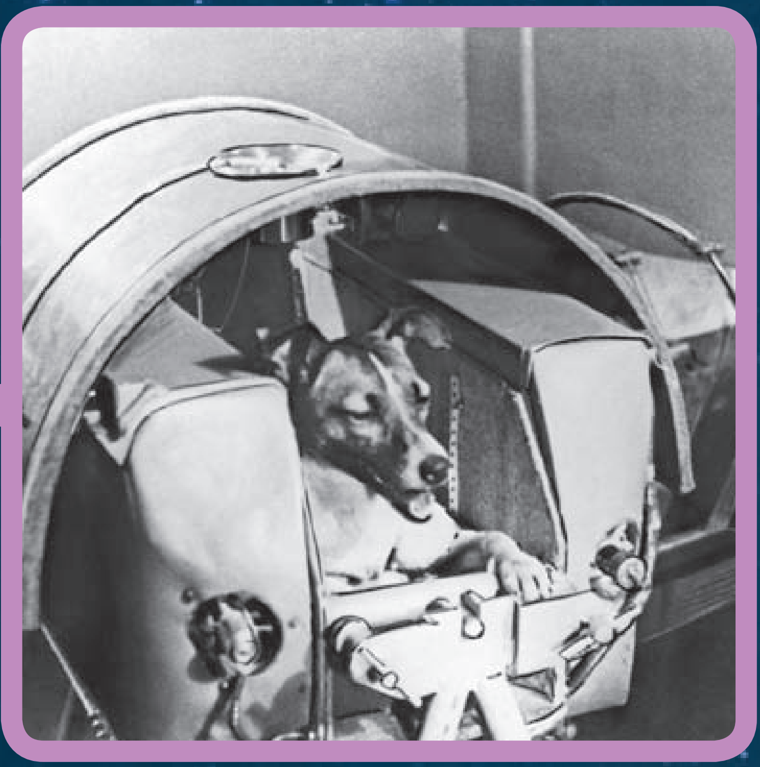
1961

Name: Yuri Gagarin
Country: Russia
Spacecraft: *Vostok 1*
Famous for: first human in space



1957

Name: Laika
Country: Russia
Spacecraft: *Sputnik 2*
Famous for: first animal in space



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MACMILLAN WALL CHARTS

Space race

Background to chart

This chart shows a time line that presents important milestones in the space race.

After World War II, North America and Russia were engaged in a Cold War. It was called a 'cold' war because there was no physical fighting, but the two countries were opposed politically and ideologically. The development of superior space technology became important for potential military use and as evidence of superiority. The space race unofficially commenced in 1957 when Russia successfully launched *Sputnik 1*, the first artificial satellite to orbit the Earth. There is some debate about when the space race ended and who won it.

1957: This photo shows Laika, a Russian dog. Laika became the first living thing to travel into space, on board *Sputnik 2*. Recent revelations confirm Laika died within a few hours of lift-off from stress and overheating. Nevertheless, the scientific results from Laika's mission paved the way for human space flight.

1961: Yuri Gagarin was a Russian cosmonaut. He became the first human in space when he orbited the Earth for 108 minutes on board *Vostok 1*.

1963: Valentina Tereshkova was a Russian cosmonaut who became the first woman in space. She spent nearly three days orbiting the Earth 45 times (once every 88 minutes) on *Vostok 6*.

1969: Neil Armstrong and Edwin 'Buzz' Aldrin were the first humans to walk on the Moon. Armstrong took this photo of Aldrin stepping down from the lunar module *Eagle*. The two spent three hours on the Moon's surface while Michael Collins remained in orbit on board the command module *Apollo 11*.

Key ideas

- The development of science and technology has enabled humans to travel into space.
- The space race was a race between communist Russia and capitalist America. They competed to demonstrate their ideological and military superiority over each other.

ACKNOWLEDGEMENTS

Laika: Corbis/Bettman
Yuri Gagarin: Corbis/Bettman
Valentina Tereshkova: Photolibrary/Science Photo Library
Buzz Aldrin: NASA/courtesy of nasaimages.org

Questions

Observing

- Describe the features of the spacecraft that carried Laika into space.
- What changes in technology have enabled space travel?

Comprehending

- Why were animals sent into space before people?
- Suggest a newspaper headline for each photo.

Applying

- What specific information was gathered about space travel from Laika's mission?

Analysing

- Why do you think there have been no further Moon landings since *Apollo 17* (1972)?
- What might each person (or animal) be thinking or feeling in the photos? Suggest thought balloons for each.

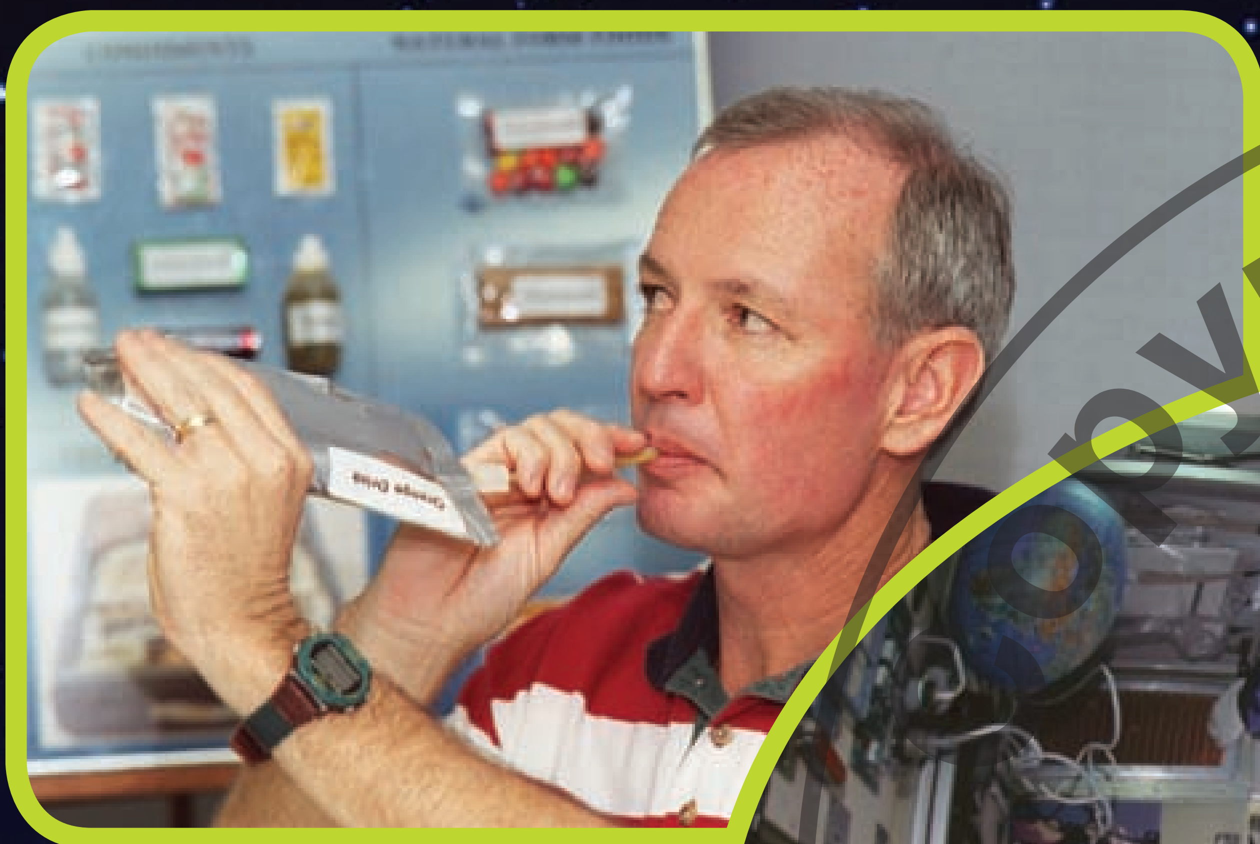
Reflecting

- How do you feel about the use of animals in space?
- What attitudes and personal qualities does someone need to be the 'first' person to travel into space?

Evaluating

- Were Armstrong and Aldrin foolhardy, incredibly brave, both or neither? Explain your opinion.
- Who do you think won the space race and why?

Living in space: Food



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Astronaut sampling a beverage: NASA/courtesy of nasaimages.org
Astronauts and cosmonauts share a meal: NASA/courtesy of nasaimages.org
Astronaut watching a spoonful float: NASA/courtesy of nasaimages.org
Astronaut preparing to eat a meal: NASA/courtesy of nasaimages.org
Astronaut eating an apple: NASA/courtesy of nasaimages.org

Questions

Observing
- Describe things in the background of each photo. What equipment, posters, signs, clothing, do you see?

Comprehending
- What are some of the difficulties about eating in space?
- Why are foods which produce crumbs banned on a space mission?

Applying
- What foods do you have at home that might have been developed for space?
- Which foods produce crumbs or fine grains and would be banned on a space mission?

Analysing
- What are the special issues relating to food in space? Why?
- Describe how food is prepared for space.

Reflecting
- What do you think is the worst thing about eating in space? Why?
- How do you think the astronauts in the photos might feel about meals in space?

Evaluating
- Do you think your favourite food would be available on a space station? Explain.
- Is taste or nutritional value more important for astronauts? Explain your opinion.

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Living in space


Rest


Exercise


Recreation

Living in space: Rest, Exercise, Recreation

Background to chart

Astronauts in space have a similar daily routine to people on Earth. They have jobs to do, they eat meals, wash themselves, and engage in recreational activities, exercise and sleep.

This chart has three photos which show rest, exercise and recreation in space. The first photo shows three astronauts in their sleeping bags. Sleeping bags need to be strapped down so the astronauts don't bump into anything while they sleep. On some spacecraft, astronauts sleep in cubbies with sliding doors.

The second photo shows astronaut Joseph Acaba using the bicycle ergometer (exercise bike) on the space shuttle *Discovery*. Microgravity in space causes bones and muscles to lose mass and strength. When astronauts return to Earth they can experience problems such as broken bones and heart disease. Exercise routines have been developed to keep astronauts fit for their return to Earth. Weight training exercises and resistance exercises using pulleys duplicate the effect of gravity and help astronauts maintain muscle tone and bone strength. Astronauts have to work with extra weights because weights are lighter in space. On space missions of less than two weeks, half an hour of daily exercise is recommended. On the International Space Station (ISS), 2.5 hours per day is essential because astronauts spend six months in space.

The third photo shows astronaut Greg Chamitoff playing chess in the Harmony Node 2 of the ISS. The chess pieces are attached using Velcro. Mental health is also important in space, especially during six-month rotations in a confined space. Astronauts can listen to music, read and use laptops to communicate with friends and family members in their spare time.

Key ideas

- Microgravity affects every aspect of life in space.
- Daily exercise in space is very important to keep astronauts fit and healthy.
- Recreation and leisure time is important for mental health in space.

ACKNOWLEDGEMENTS

Astronauts in sleeping bags: NASA/courtesy of nasaimages.org
Joseph Acaba: NASA/courtesy of nasaimages.org
Greg Chamitoff: NASA/courtesy of nasaimages.org

Questions

Observing

- What do you notice about the sleeping arrangements in the first photo?
- What special provisions are necessary to be able to play chess or use exercise equipment in space?

Comprehending

- How and why are sleeping bags secured on a spacecraft?
- Why is physical exercise important for staying healthy in space?

Applying

- What other recreational games could be used in space and how would they need to be modified?
- How well do you think you would sleep in space?

Analysing

- Why is recreation an important part of an astronaut's routine?
- How much time should be allowed for recreation each day on a space station?

Reflecting

- How would you spend your leisure time on a space station?
- What games or activities would you miss most if you lived on a space station? Why?

Evaluating

- How do you think you would cope in space for 14 straight months (the record for time spent in space)?
- What do astronauts need to think about when living and working with people from different backgrounds on the ISS?

Living in space: Hygiene

MACMILLAN WALL CHARTS

Living in space: Hygiene

Background to chart

Clockwise from top left:

Waste Management System Toilets in space have leg restraints and thigh bars to prevent astronauts from floating away. There is no water for flushing; running water cannot be contained in microgravity and would be dangerous on a space vehicle. Waste matter is sucked away and sealed in plastic bags. Astronauts use individual urine funnels to collect their urine for recycling.

Brushing hair Microgravity makes it difficult for astronaut Tracy Caldwell to brush her hair without it standing up.

Shaving Astronaut James Voss shaves using an electric razor as running water is not available.

Cleaning hair, bodies and teeth Astronauts cannot use running water, so they have to clean their hair with shampoo that does not require rinsing. They also wash their bodies using wet wipes or sponges and a soap that does not need to be rinsed off. Astronauts can brush their teeth but they have to swallow their toothpaste or spit it into a wash cloth.

Cutting hair Astronaut Koichi Wakata cuts his hair using a vacuum hose to suck away the freshly cut hair. The vacuum is necessary to prevent loose hairs floating away and getting into the air the astronauts breathe. Astronauts must use roll-on rather than spray deodorants for the same reason.

Not pictured Astronauts can't do laundry because there is no water available. Nor can they pack six months' worth of clothes, so they have to wear the same clothes for many days. Luckily, clothes don't get as dirty in space. Sometimes astronauts' dirty clothes are returned to Earth with them, but often the dirty laundry is loaded onto a non-reusable supply vessel and sent off into space to burn up upon re-entry into the Earth's atmosphere.

Key ideas

- Hygiene tasks are more complicated in space; many require modified equipment and procedures.
- Water is precious in space and has to be continually recycled.

ACKNOWLEDGEMENTS

Space toilet: NASA/courtesy of nasaimages.org
Tracy Caldwell: NASA/courtesy of nasaimages.org
James Voss: NASA/courtesy of nasaimages.org
Astronaut preparing to clean hair: NASA/courtesy of nasaimages.org
Koichi Wakata: NASA/courtesy of nasaimages.org

Questions

Observing

- Describe how an astronaut would perform each hygiene activity in the photos.

Comprehending

- Why does a space toilet use suction to collect the waste matter?
- Why can't astronauts use spray deodorants in space?

Applying

- How would you feel about using no-rinse soap and shampoo?
- Suggest a set of instructions for managing particular hygiene tasks on a space station.

Analysing

- Why is it necessary to recycle urine and used water in space?
- Why can't astronauts pack enough clean clothes for their mission?

Reflecting

- Why do astronauts bother with haircuts and shaving on a space station?
- What do you think happens if you get sick on a space station?

Evaluating

- Which hygiene activity would you find most difficult to get used to in space? Why?
- Why is it extremely important to stop the spread of germs in space?

Extravehicular Mobility Unit

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Extravehicular Mobility Unit

Background to chart

This astronaut is working outside the space vehicle during an extravehicular activity (EVA) or spacewalk. Astronauts sometimes need to work outside their space vehicles to make repairs or help build the space station. A spacewalk can last up to eight hours.

To survive during these activities, an astronaut must wear a complicated spacesuit and life support system called an Extravehicular Mobility Unit (EMU).

The **Primary Life Support Subsystem** (**PLSS**) is covered in protective layers of cloth and attached to the back of the spacesuit. The PLSS pumps oxygen into the spacesuit and removes carbon dioxide. It holds water cooling equipment and a fan to keep the astronaut from overheating. An alarm sounds if there is something wrong with the suit.

The **Displays and Control Module** (**DCM**) is the control panel for the spacesuit. It controls all the suit's functions including the primary life support system. A wrist mirror is worn so that the astronaut can see the display on the front. Everything on the display is written back-to-front.

A **cuff checklist** attached to the astronaut's arm lists all the tasks that need to be done.

The **helmet** has a thin layer of gold which acts as a filter for the sun's dangerous rays. The visor is toughened to protect the astronaut from objects that might strike the visor. A camera can be attached to the visor to send images inside the space vehicle or to Earth. A tube projecting into the helmet connects to a pouch of water so the astronaut can drink.

Tethers attach the spacewalker to the vehicle so the astronaut does not float away.

The **Simplified Aid for EVA Rescue** (**SAFER**) is a nitrogen powered backpack that can propel an astronaut through space if the tethers become detached. A joystick is used to control the jetpack.

Key ideas

- EMUs provide protection and a means of survival for astronauts to undertake EVAs.
- Everything that an astronaut needs for a long spacewalk is part of the EMU.

Questions

Observing
- Describe the features of an EMU.
- What can you see in the background of the photo?

Comprehending
- Explain the function of each part of the unit.
- How comfortable does the EMU look? Why do you say that?

Applying
- Describe what the astronaut might see and hear?
- Why does oxygen need to be supplied to, and carbon dioxide removed from, the EMU?

Analysing
- If it's cold in outer space, why would an astronaut be in danger of overheating?
- Compare protective clothing for occupations such as deep-sea diving, firefighting, race car driving or the defence forces.

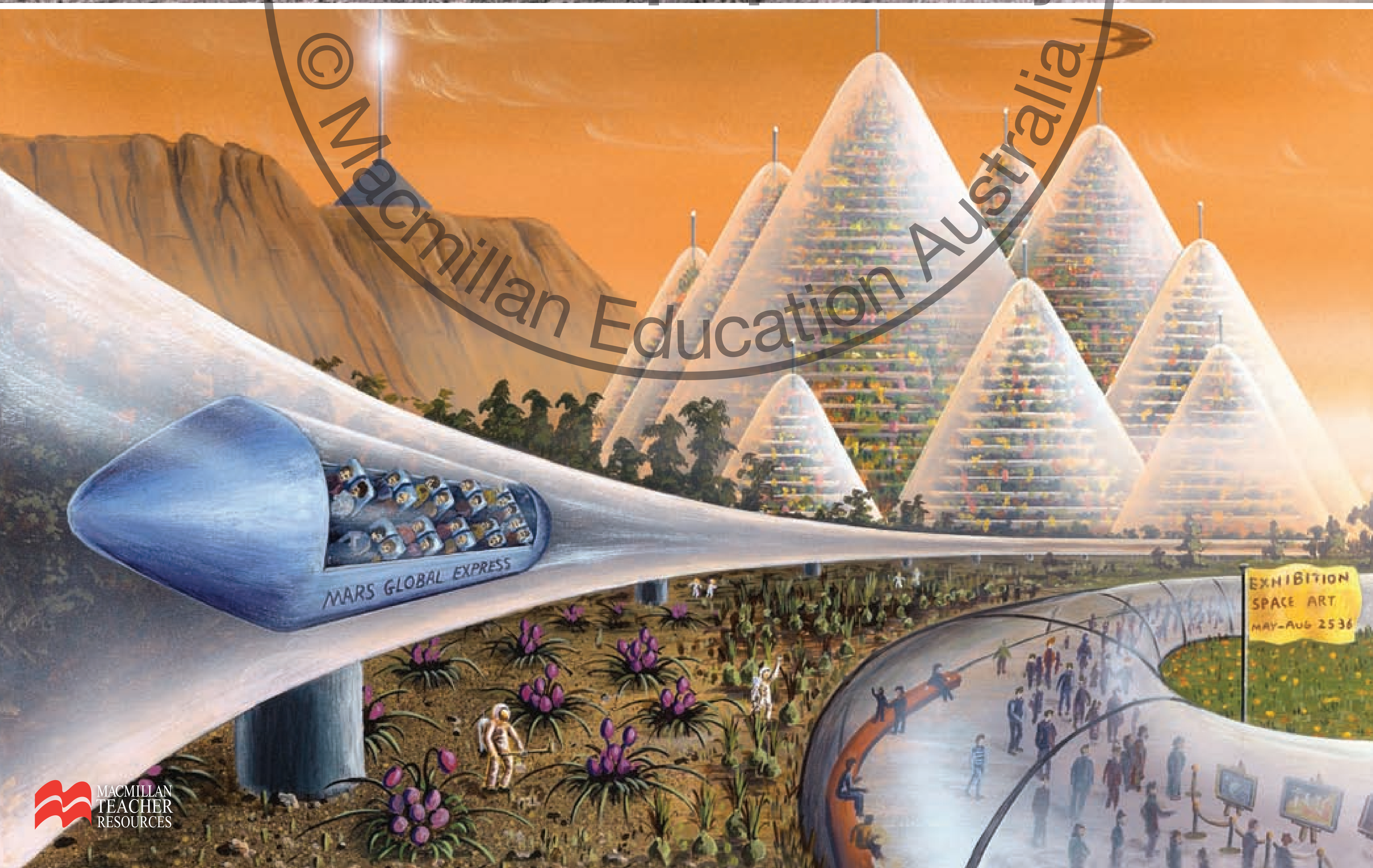
Reflecting
- Describe how the astronaut in the photo might be feeling. Suggest a speech balloon for him.
- How would you feel in the astronaut's position?

Evaluating
- List the parts of an EMU in order of importance.
- Of deep-sea diving and spacewalking, which do you think is the most dangerous? Why do you think that?

ACKNOWLEDGEMENTS

Extravehicular Mobility Unit: Photolibrary/ Science Photo Library

Space colonies



MACMILLAN WALL CHARTS

Space colonies

Background to chart

The main reasons for establishing a permanent base on the Moon are: to access the Moon's resources; for launching expeditions to Mars and beyond; for further space research.

China, Russia, North America and a Swedish-based international consortium all have plans to establish a lunar base in the future. North America proposes to have people live and work on the Moon for extended periods of time. It also has a Mars Exploration Program which aims, among other things, to establish whether or not life ever existed on Mars.

Top illustration: is an artist's impression of a future mining site on the **Moon**. The artist has depicted an oxygen harvesting facility. Oxygen will be needed for people to inhabit the Moon, so finding ways to harvest it on the Moon is vital.

The Moon's soil is rich in iron, aluminium, magnesium, titanium and other elements which could be used in a lunar metals production plant for shipment to Earth. A substance called Helium-3 is also found on the Moon. It is very rare on Earth, but is potentially a rich source of energy for fuelling the Earth's power needs and for supporting exploration to Mars and beyond. Helium-3 is currently thought to be an environmentally friendly energy source.

Bottom illustration: shows an artist's impression of a future colony on **Mars**. Scientists believe the environment on Mars could once have supported life as it used to have large oceans, a thick atmosphere and polar caps that were similar to Earth. Today, Mars has similar geological features to Earth, such as volcanoes and deserts, but the atmosphere contains too little oxygen to support human life, and its oceans have long since dried up and all that remains is salt in the soil. However, snow sometimes falls and fog, frost and ice are common in the mornings on Mars.

More study and exploration by robots is required before humans can safely establish a colony there, but it is not beyond the realms of science to do so.

Key ideas

- Scientists believe that the Moon will provide useful resources for Earth.
- A permanent base on the Moon can be used as a launching point for further space exploration.
- Travelling to, and living on, the Moon or Mars are dangerous and difficult missions.

Questions

Observing

- Where do you think each of these space colonies is? What do you see in each illustration to make you think that?

Comprehending

- What differences would there be between living on the Moon and on Mars?
- What do you think is happening in each illustration?

Applying

- What things do scientists need to consider when designing a lunar base?
- How would you design a space colony on Mars?

Analysing

- What aspects make travel to Mars so dangerous for astronauts?
- What problems could inhabitants of a lunar base experience?

Reflecting

- How can the Moon's resources be shared equitably among the Earth's peoples?
- How should the Moon's environment and resources be managed?

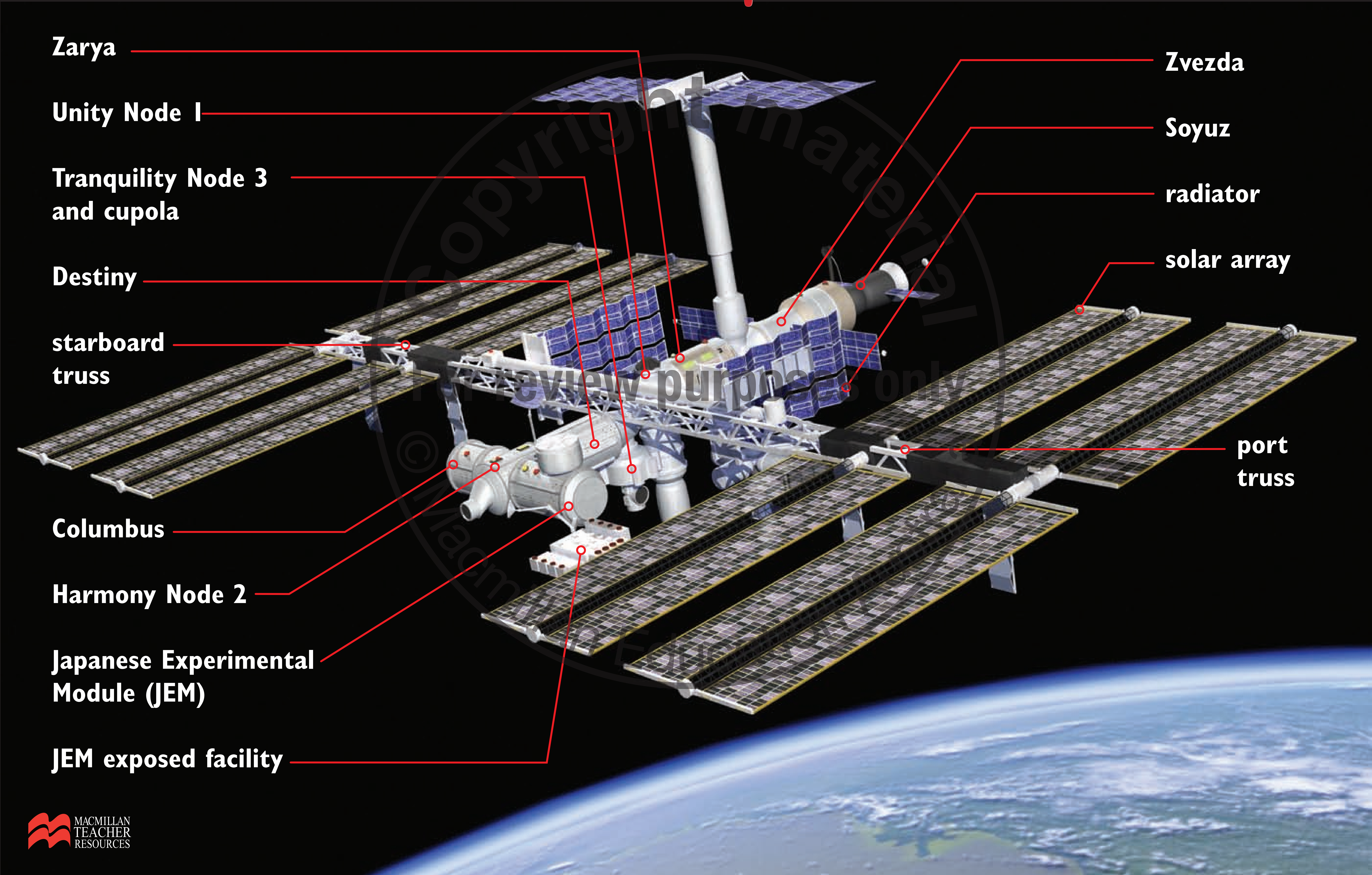
Evaluating

- What do you think are the benefits of setting up a permanent lunar base?
- What do you think are the advantages and disadvantages of exploring Mars?

ACKNOWLEDGEMENTS

Moon colony: NASA/courtesy of nasaimages.org/Pat Rawlings
Mars colony: Photolibrary/Science Photo Library/Richard Bizley

International Space Station



International Space Station

Background to chart

The International Space Station (ISS) is a research facility jointly funded by North America, Russia, Europe, Japan and Canada. Brazil and Italy are involved in special projects. The ISS can be seen from Earth and is the size of a football field. It orbits the Earth at a speed of 28 000 kilometres per hour, maintaining this speed to stay in orbit.

Construction began, in orbit, in 1998. The station has been continually crewed since November 2000, with missions usually lasting six months.

Some sections of the ISS are:
The **Integrated Truss Structure**, the backbone of the ISS, which includes the **starboard truss** and **port truss**.
The **solar array** houses solar panels that convert sunlight to DC power.
The **radiator** is the cooling system.
The **Zarya Module** was the first section of the ISS to be launched. Initially it was used for electrical power, communications and orientation control, but now is primarily used for storage and its external fuel tanks.
The **Zvezda Service Module** has many functions such as providing living quarters, electrical power, flight control, data processing and propulsion systems, and remains the structural and functional centre of the Russian sector.
Destiny is the US research laboratory.
Columbus is the European research laboratory.
Japanese Experimental Module (JEM) is the Japanese research laboratory.
The JEM Exposed Facility is an external platform used to conduct research in the exposed environment of space.
Unity Node 1 connects living and work areas. It is used for storage and is where astronauts can exercise.
Harmony Node 2 links the three international laboratories and increases the station's living and work space.
Tranquility Node 3 contains the life support system which recycles waste water and generates oxygen. It supports a cupola which has a flight deck and windows for Earth observations.
Soyuz spacecrafts are used for crew rotation, emergency evacuation, and carrying supplies and equipment.

Key ideas

- The International Space Station is a research facility operated and funded by a consortium of nations.
- The ISS is permanently staffed, with crew usually working for six months before rotating back to Earth.

ACKNOWLEDGEMENTS

International Space Station: Photolibrary/Science Photo Library

Questions

Observing
- What do you notice about the structure of the ISS?

Comprehending
- Why is the integrated truss structure a useful structure for the ISS?
- What could be some disadvantages of this structure?

Applying
- What are the advantages of having laboratories in space on a permanent basis?

Analysing
- How does the ISS travel in space?
- How can experiments on humans working on the ISS assist in understanding how humans will cope with the long flight to Mars?
- How would you persuade other countries to become involved in the work of the ISS?

Reflecting
- What do you think about the use of the ISS by tourists who pay approximately US$25 000 000 for their trip?
- What would happen to the crew of the ISS if war started between the countries which operate it?

Evaluating
- What do you think are the advantages of international cooperation on the space station?
- Do you think Australia should become involved in the ISS? Justify your opinion.

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Space technology on Earth

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MACMILLAN WALL CHARTS

Space technology on Earth

Background to chart

Technology developed or refined for use in space can have spin-off uses or benefits back on Earth.

Racing swimsuit Speedo asked NASA to help design a swimsuit for racing, based on NASA's experience with studying forces of friction and drag. Ninety-four percent of gold medals in swimming at the 2008 Olympics were won in the new Speedo suit.

Cordless power tool In the 1960s, NASA contracted Black and Decker to create a cordless rotary hammer drill to extract rock samples from the Moon's surface. Although cordless power tools existed before NASA's involvement, a result of the collaboration was that Black and Decker created other tools to benefit humans, including cordless medical instruments and the Dustbuster.

GPS receiver The Global Positioning System is made up of satellites orbiting the Earth, monitoring stations on Earth, and receivers owned by users. The radionavigation system was first developed for use in space. It is now free for use by anyone with a GPS receiver.

Water filter NASA developed advances in water filtration to sterilise astronauts' drinking water in space. On Earth, this is vital for areas with contaminated water or no drinking water.

NASCAR Thermal protection system (TPS) materials were developed to safeguard space shuttles from excessive heat upon re-entry into the Earth's atmosphere. This fire-resistant material is now used in NASCAR racing cars to protect drivers from the extreme engine heat. It is also used to protect firefighters.

Diving suit NASA research and technology was used to create diving suits capable of protecting deep-sea divers from hazardous environments such as toxic spills, chemical warfare agents or high pressure in deep seas.

CAT scan NASA made developments in digital imaging technology to enhance pictures of the Moon. CAT scans and MRIs use this computer imaging technology to show soft tissue, internal organs and bones which helps diagnose and treat medical conditions.

Teflon frying pan Teflon was invented in 1938. It was used to coat frying pans to create a non-stick surface for cooking food. NASA raised the profile of the trademark when it used Teflon to coat heat shields, spacesuits and cargo hold liners to reduce friction in space.

Ear thermometer An ear thermometer detects infra-red energy or heat. The technology used in ear thermometers was developed to measure the temperature of distant stars and planets.

Key ideas

- Technology created for or refined by the space program can lead to innovations and different uses on Earth.

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Diving suit: NASA Spinoff
CAT scan: Shutterstock/Laurent Dambies
Frying pan: Shutterstock/Paul Paladin
Ear thermometer: iStockphoto/Melissa King

Questions

Observing
- Describe the items on the front of the poster. How is each one used on Earth?
- How is the diving suit similar to a spacesuit?

Comprehending
- How might each item have been used, or developed from something used, in space?

Applying
- How does water become contaminated?
- What special feature would the Black and Decker cordless rotary drill have needed to extract rock samples on the Moon?

Analysing
- What tests would NASA have used on the cordless drill for the Moon?

Reflecting
- Is space technology worth the cost?
- What tools developed by space agencies do you think are the most useful?

Evaluating
- Why do you think space agencies such as NASA work with private industry?
- If a space agency such as NASA is funded by the government, what should happen with the technology it invents?