Science & play® LAB

Mars Exploration

What will life on Mars be like?

WARNING. • Warning. Not suitable for children under 8 years. For use under adult supervision. • Read the instructions before use, follow them and keep them for reference. • Keep small children and animals away from experiments. • Keep the experimental set out of reach of children under 8 years old. • Adult supervision is required when doing these activities.

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Read and keep the instruction manual for future reference.

Clementoni®

SAFETY RULES

- Read these instructions before use, follow them and keep them for reference.
- Keep young children and animals away from the experimental area.
- Store this experimental set out of reach of children under 8 years of age.
- Clean all equipment after use.
- Make sure that all containers are fully closed and properly stored after use.
- Ensure that all empty containers are disposed of properly.
- Wash hands before and after carrying out experiments.
- Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.
- Do not eat or drink in the experimental area.
- Do not replace foodstuffs in original container. Dispose of immediately.
- Be careful when handling hot water and other hot solutions.
- All stages of gel preparation requiring the use of a microwave oven and cooker must be performed by an adult.
- If you spill any liquid on the floor, wipe it up immediately so you don't slip.

ADVICE FOR SUPERVISING ADULTS

- Read and follow these instructions and the safety rules, and keep them for reference.
- Keep the experimental set out of reach of children under 8 years old.
- Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which experiments are suitable and safe for them.
- The instructions should enable supervisors to assess any experiment to establish its suitability for a particular child.
- The supervising adult should discuss the warnings and safety information with the child or children before commencing the experiments.
- **Particular attention should be paid to the safe handling of hot water and other hot solutions.**
- The area surrounding the experiment should be kept clear of any obstructions. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.

CAUTIONS AND GUIDELINES FOR USING THE SEEDS

Not for use in agriculture for seed reproduction purposes. The seeds in the sachet are for educational purposes only and must be used as described in the instruction booklet. Not for human consumption. Dispose of responsibly. Do not discard in the environment. Phytosanitary certification.

WARNINGS

When you have used all of the seeds in the box, you can buy others from specialist seed suppliers.

Do not use seeds for human consumption, as they have been dried.

ASK AN ADULT TO HELP YOU!

Ask an adult to remove the plastic pieces. Any remaining sharp pieces must be thrown away immediately.

COMPONENTS OF THE KIT

- **COMPONENTS OF THE MARTIAN BASE**
- **ASTRONAUT MODELS**
- **STICKERS**
- **SOLAR PANELS**
- **ROCKS**
- **PEAT**
- **CLOVER SEEDS**
- **PREPARATION FOR GEL**
- **GRADUATED BEAKER**
- **PIPETTE**
- **SPATULA**
- **TEASPOON**


x1 lower base


x1 upper base


x1 stickers


x3 feet for central base


x1 dome


x1 antenna


x1 grabbing arm


x1 arm base


x1 support for solar panels

x1 dome bracket


x1 parabolic antenna


x4 feet for transparent modules


x4 solar panels


x1 square antenna


x2 astronaut models


x5 module ends


x6 rover wheels


x2 module covers


x2 module bases


x3 upper connector pieces


x3 lower connector pieces


x1 elastic band


x1 preparation for gel


x1 clover seeds


x1 rocks


x3 peat pellets


x1 rover module base


x1 rover cabin


1x rover module cargo bed


1x windscreen


x1 rover cabin closure


x1 graduated beaker

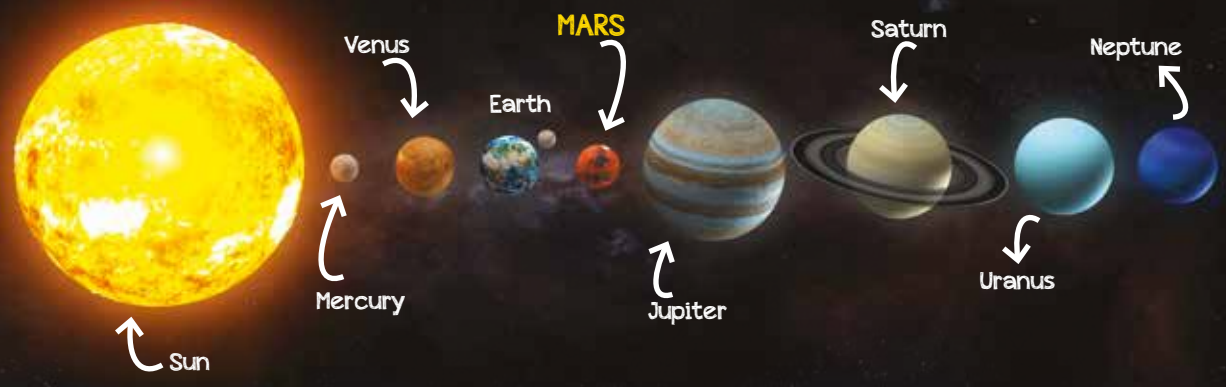

x1 spatula


x1 teaspoon


x1 pipette

CONTENTS

MARS AND THE SOLAR SYSTEM



Mars is the fourth planet in our solar system. Along with Mercury, Venus and the Earth, **it is one of the rocky planets**, characterised by a solid surface. Jupiter, Saturn, Uranus and Neptune are classed as gas giants. They do not have a real surface: in fact, if we tried to land on one of these planets, we would fall through a cloud of gas that becomes increasingly dense until it reaches a liquid state.
Mars has an average distance of 225 million kilometres from the Earth. To give you an idea of just how great this distance is, just think that the fastest car in the world, which reaches an incredible speed of 532 km/h, would take almost 50 years to reach the Red Planet!

Mars is a dusty, cold and desert world, with a very thin atmosphere, yet it is also a highly dynamic planet. It has seasons, polar ice caps, deep canyons and extinct volcanoes, and there is evidence that in the remote past it had seas and oceans, just like Earth.
It is often referred to as **"the Red Planet"** due to the colour of its surface, generated by the presence of iron and iron oxide in the soil.

SATELLITES OF MARS

The two small satellites, discovered by the American astronomer Hall in 1877 orbit the planet and **have the ancient Greek names of Phobos** (fear) and **Deimos** (terror), the sons of Ares in Greek mythology (Mars in Latin).
Unlike our Moon, these two satellites have an irregular shape, but just like the Moon they always face the planet with the same side. **Phobos**, the largest one, measures approximately 27 x 22 x 18 km, **and orbits the planet in eight hours**. **Deimos** is smaller (approximately 15 x 12 x 10 km), **and orbits Mars in 30 hours** at a speed of 1.3 km per second.

THE ANCIENT OCEANS OF MARS

We are now aware that **Mars** has not always been the desert planet that we all know. The most widely accepted theories state that **more than 3 billion years ago the surface of the planet was covered in oceans and lakes**, just like the Earth. The atmosphere was denser, temperatures milder and, who knows... maybe there was life on this planet!

So, where did all the water go? **With an average temperature of -63°C, it is impossible to find water in a liquid state on the surface**. To find water, we have to look to the polar ice caps. With great surprise, it was discovered that there are huge deposits of frozen water under the frozen CO_2 that covers the poles. There is also frozen CO_2 here on Earth, called **"dry ice"**, which is often used in performances to create smoke. In an atmosphere like Earth's, dry ice passes directly from a solid state to a gaseous state without first being turned into a liquid.

OLYMPUS MONS

Mars is home to the highest peak in the entire solar system: Olympus Mons (Mount Olympus). This extinct volcano rises to **25 km in height**! To draw a comparison, the highest mountain on Earth, Mount Everest, is "only" 8.9 km high.

AN ENORMOUS CANYON

Along the equator of the planet, it is possible to admire the greatest expanse of valleys on the planet, the **Valles Marineris**. Named after the Mariner 9 space probe, the Valles Marineris **are a vast complex of parallel valleys dominated by immense canyons**. These valleys stretch across the Martian landscape for 4000 km, reaching a width of 700 km, and can be up to 11 km deep. The entire complex is very similar to the Grand Canyon here on Earth, but it is ten times longer, seven times wider and seven times deeper. In certain points, there are visible signs of ancient channels formed by water or CO_2.

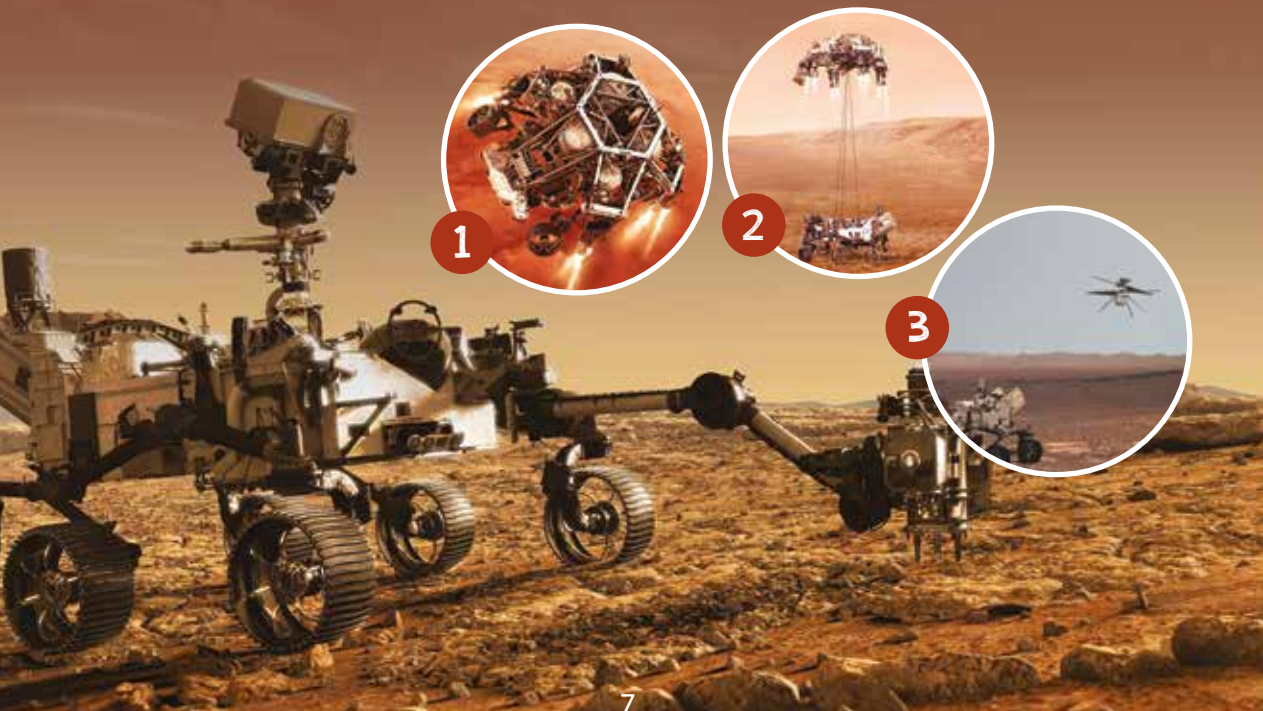
The large channels observed by space probes show evidence of water erosion in ancient times.

EXPLORATION OF MARS

Mars is one of the best explored planets in our solar system and **it is the only one on which we have landed rovers to study the alien surface**. **Two NASA rovers** are currently exploring the surface of Mars and there are eight artificial satellites orbiting the Red Planet to study it from above. Scientists want to discover whether Mars was home to forms of life in the past and whether it would be able to support human life in the future. Back in 1960 the first probes were launched for the Red Planet, but it was only **in 1976 that the Viking probes successfully landed on the surface**, giving the world the first breathtaking images of the Martian landscape.

PERSEVERANCE: SEARCHING FOR LIFE

On 18 February 2021, the Mars 2020 mission successfully landed the rover **Perseverance** on the surface of Mars. The captivating landing manoeuvre was completed in two phases: first a parachute slowed the descent of the module and then the Skycrane (a self-propelled aircraft) lowered the rover to the surface using cables. **Will Perseverance help us answer the big question: has there ever been life on Mars?** Throughout its stay, **Perseverance** will examine the Martian surface and collect rock samples that it will store until, during the next mission, the samples will be withdrawn and brought back to Earth for detailed analysis to search for the fossilised remains of microbial life. **Perseverance** it not alone on its voyage. The small helicopter **Ingenuity**, also on Mars thanks to the Mars 2020 mission, **has already entered the history books as the first aircraft ever to fly on another planet!**



COLONISATION
AN EXTREME ENVIRONMENT

Although **Mars** and the Earth are similar in many ways, the environmental differences make Mars an extremely difficult place to colonise.
The main problem is the atmosphere: **Mars has a very thin atmosphere that is low in oxygen, making it impossible to live outdoors without a pressurised space suit** equipped with oxygen tanks. Mars **is also extremely cold**: despite the fact that at the equator, when the sun is high, temperatures can reach highs of 20°C, as you move towards the poles, the temperature drops to a minimum of -153°C, with an average temperature of -63°C. A huge amount of energy would be needed to keep warm on Mars!
Martian winds can sweep across the surface at speeds of up to 80 km/h. Because it is a very dry place, **the wind causes gigantic sandstorms that can last for weeks**. In 2018, **NASA** observed a massive storm that lasted almost one month and covered the entire planet during its final phases. The storm stopped solar rays from penetrating and the surface temperature dropped even further for several days. Another great danger comes directly from space: **cosmic radiation**.

This is very dangerous radiation that astronauts encounter when they set off on space voyages. The Earth has a magnetic shield that protects it from cosmic radiation and actually redirects radiation into space. Unfortunately, Mars does not have such a shield, therefore astronauts would need to find alternative ways to protect themselves, also considering the long duration of colonisation missions.

Opportunity Rover

HABITAT FOR ASTRONAUTS

On **Mars,** astronauts will need a permanent base station (called a habitat), that reproduces the environmental conditions on Earth, in which they can move around without a space suit, work in laboratories, eat and rest. The entire station will be **pressurised**, meaning that the air pressure inside will be greater than outside (due to the thin atmosphere on Mars). The station will be equipped with everything needed for the survival of the first settlers, and with equipment essential to carry out scientific experiments of all kinds.
Engineers and designers will be faced with huge challenges: they will need to create **systems capable of generating electricity** from renewable sources such as solar energy or wind power. In addition, the station will require services to enable human life, such as **systems to produce oxygen and food and to recycle water.** It would be extremely difficult to transport large quantities of water to Mars, so it is necessary for the majority of water used to be purified and re-used. Another option that scientists are working on is to **collect water already present on Mars in the form of ice or water vapour.**

TRAVELLING ON MARS

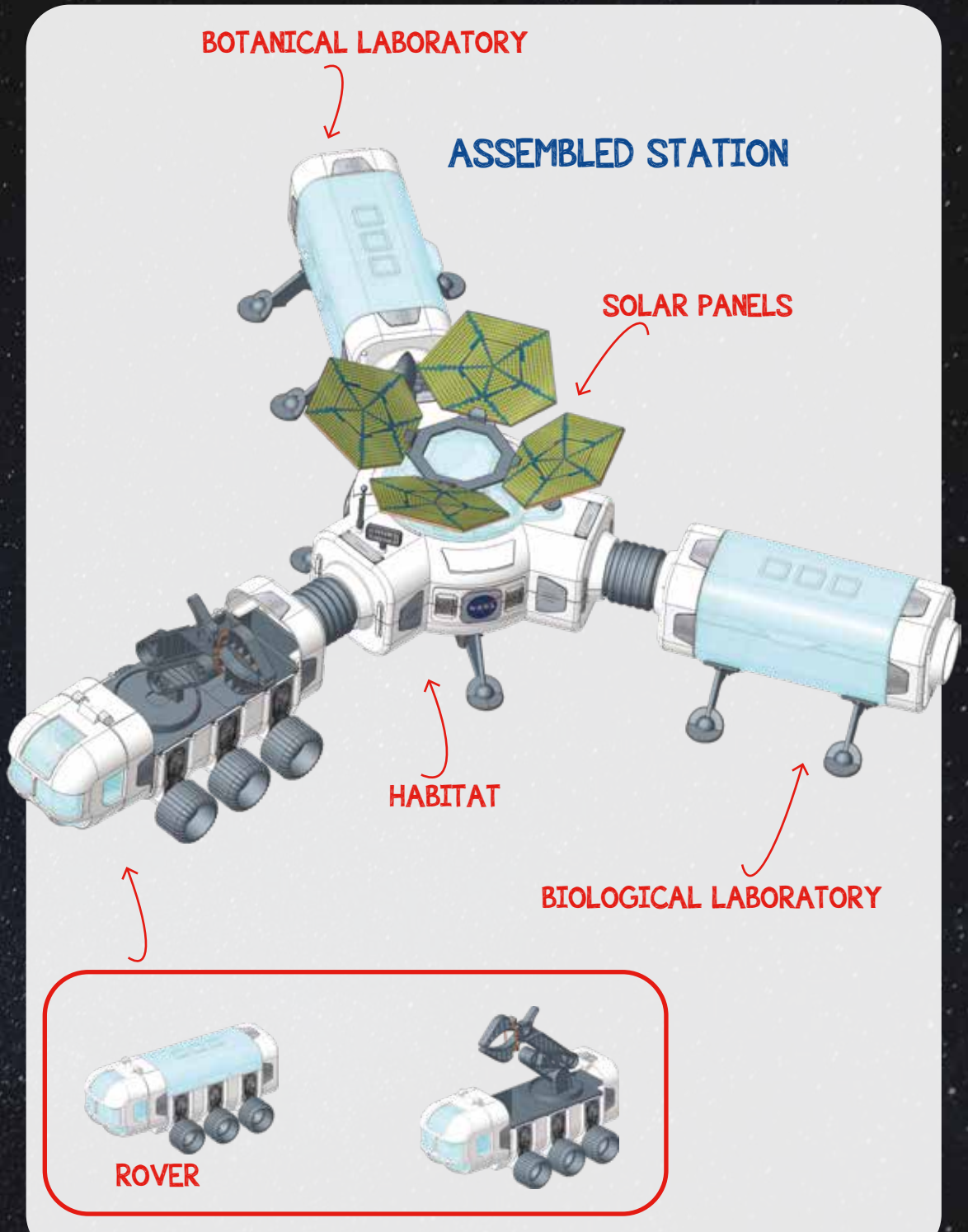
In 2008, NASA completed the first working prototype of the **LER (Lunar Electric Rover) vehicle**. The vehicle has a modular structure: a large cabin is mounted on a frame with six pairs of wheels*. This modular structure enables the vehicle to be sent to the Red Planet piece by piece and then re-assembled. Just like the habitat, the LER module is pressurised, and the rounded shape of the cabin has been specially designed to offer maximum structural stability. Special dome-shaped glass enables astronauts to observe and study rocks and extra-terrestrial materials up close. In addition, the rear of the cabin has two space suits, which are easily accessible from inside the cabin itself. The six pairs of wheels* of the frame are all independent: each can rotate fully and each has a shock absorber. All of these features mean that the **LER** is an extremely versatile vehicle that can be driven on any type of ground, even if it is very uneven, and can overcome any obstacle.

*to simplify assembly, the vehicle in the kit has six wheels instead of 12

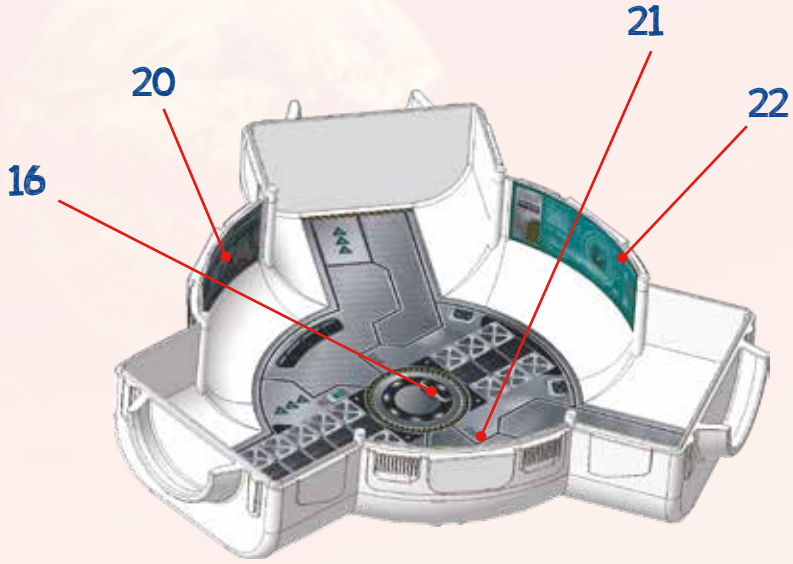
THERE AND BACK

A last essential element for our future Martian base is a return vehicle.
To bring settlers and samples collected on the Red Planet back to Earth, the bases must be equipped with powerful self-propelled vehicles capable of surviving the journey to Mars and the extreme conditions on the surface, before being relaunched back home.
New technology will be needed for landing and take-off manoeuvres in the thin Martian atmosphere, where normal mechanical features such as ailerons and flaps may not be sufficient to stabilise the spacecraft. The **MAV** vehicle (acronym for **Mars Ascent Vehicle**) is currently in the design phase, and one day it will enable man to travel to and from the Red Planet.

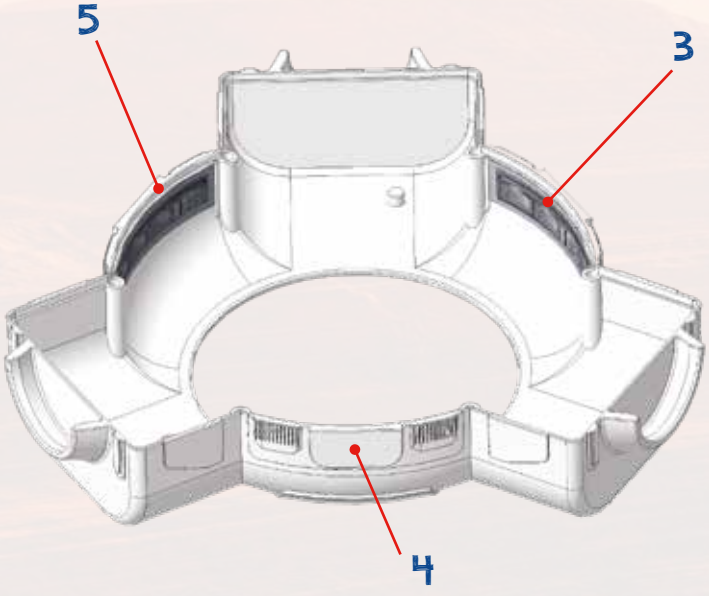
BUILDING THE MARTIAN BASE STATION



1 Apply the stickers to the INSIDE of the Martian base as shown in the image.



2 Apply the stickers to the TOP of the Martian base as shown in the image.



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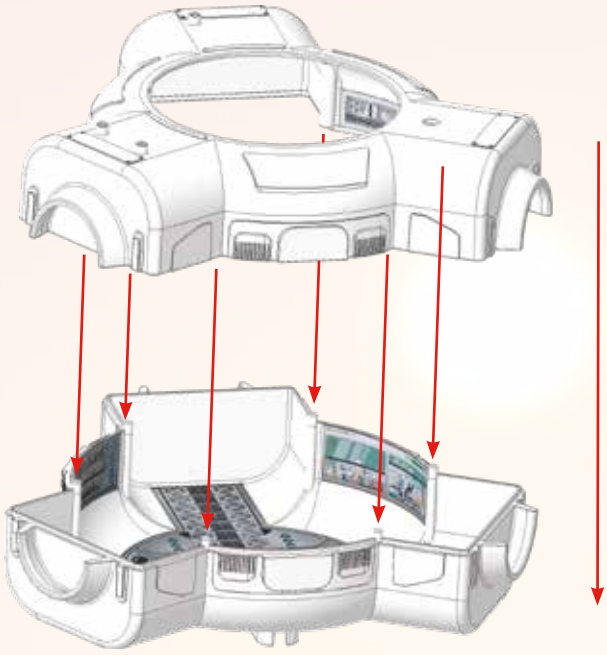

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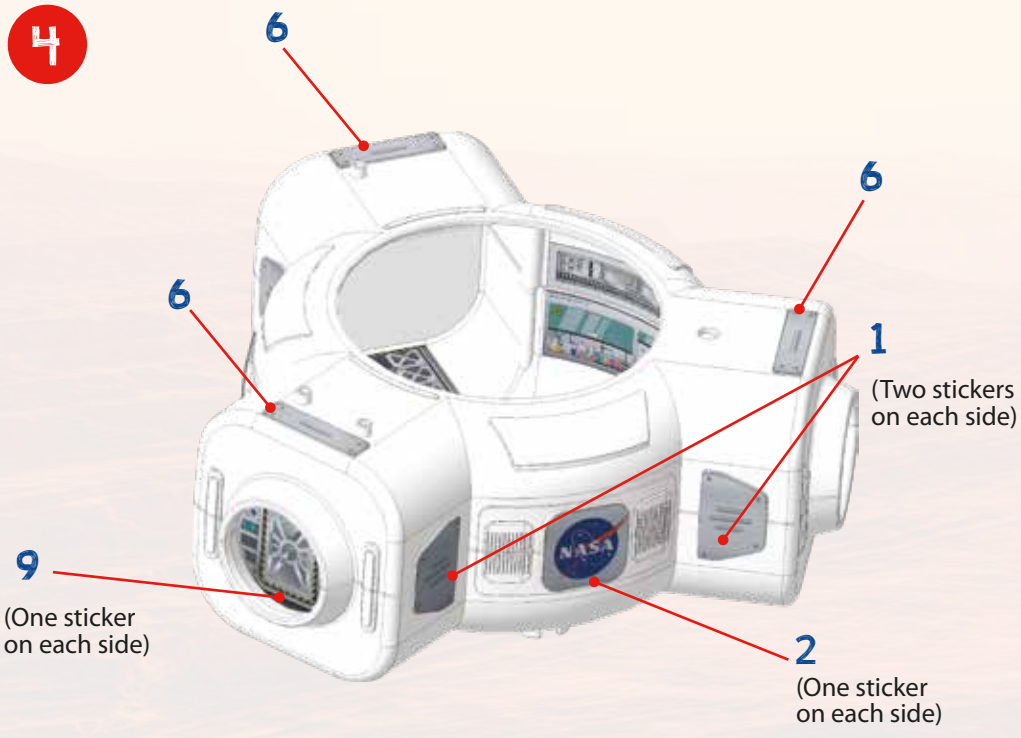
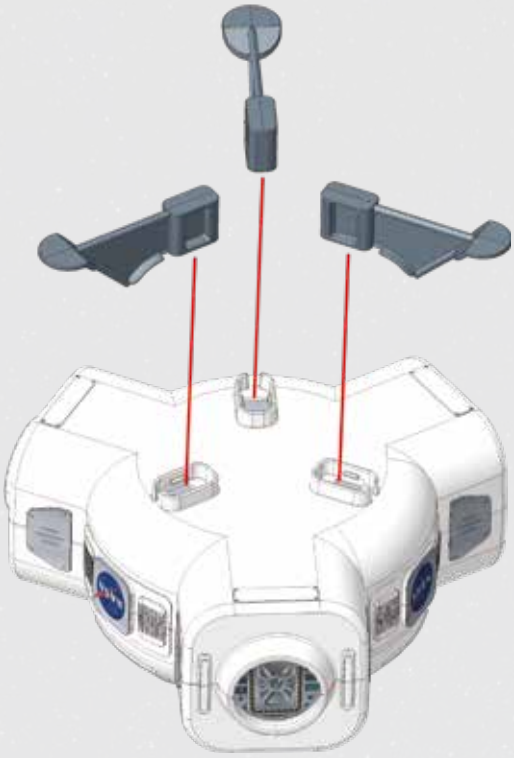

6
6
6
1
(Two stickers
on each side)
9
(One sticker
on each side)
2
(One sticker
on each side)

5



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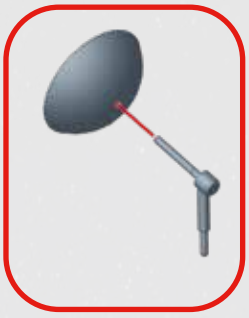

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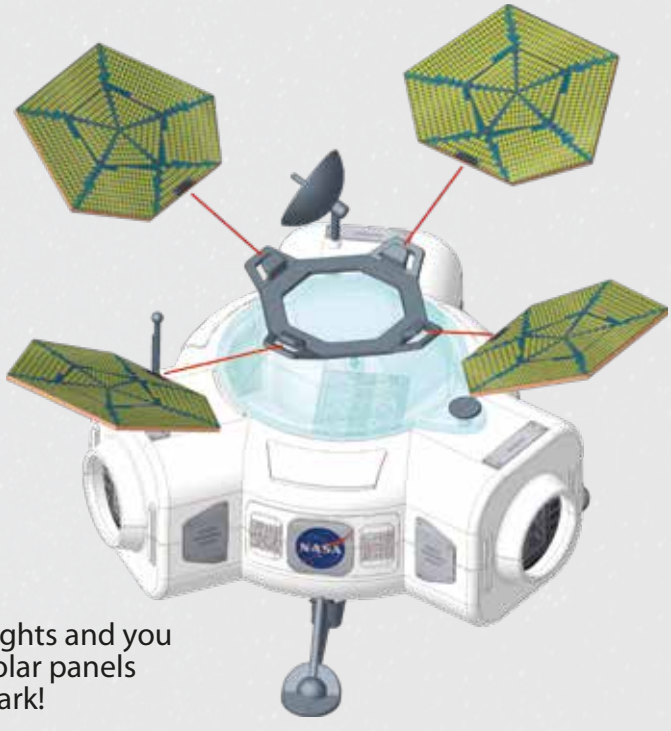
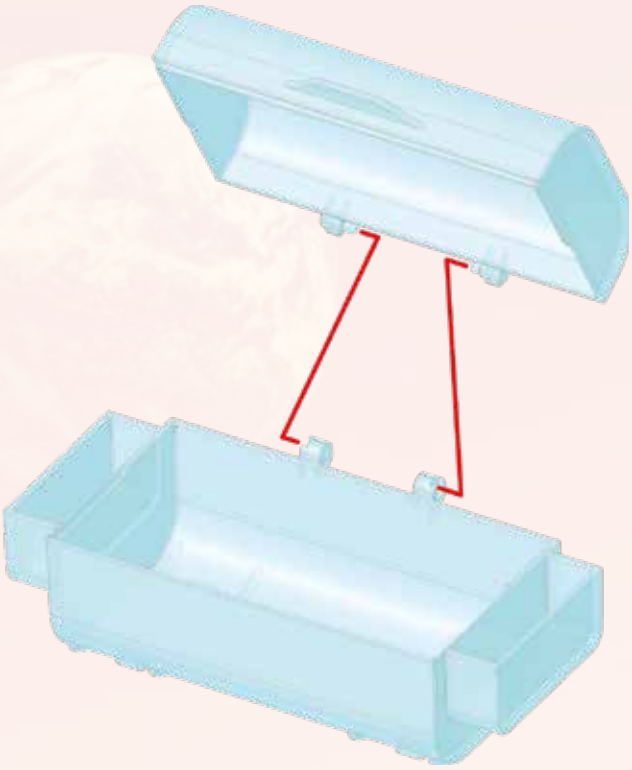


Turn off the lights and you will see the solar panels glow in the dark!

9



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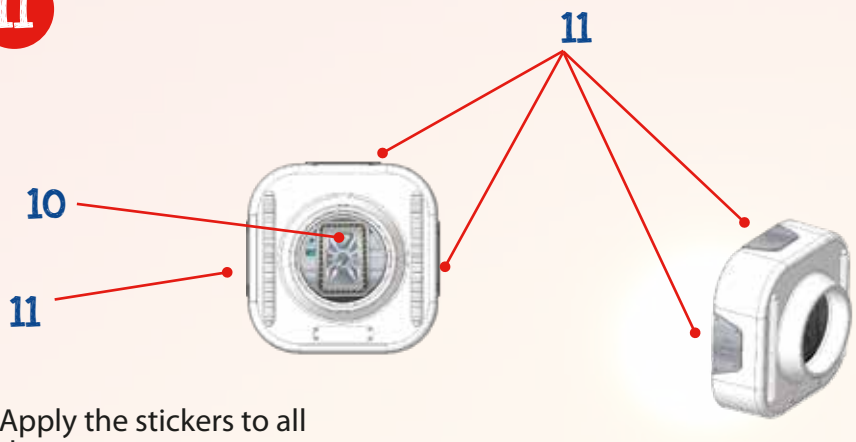
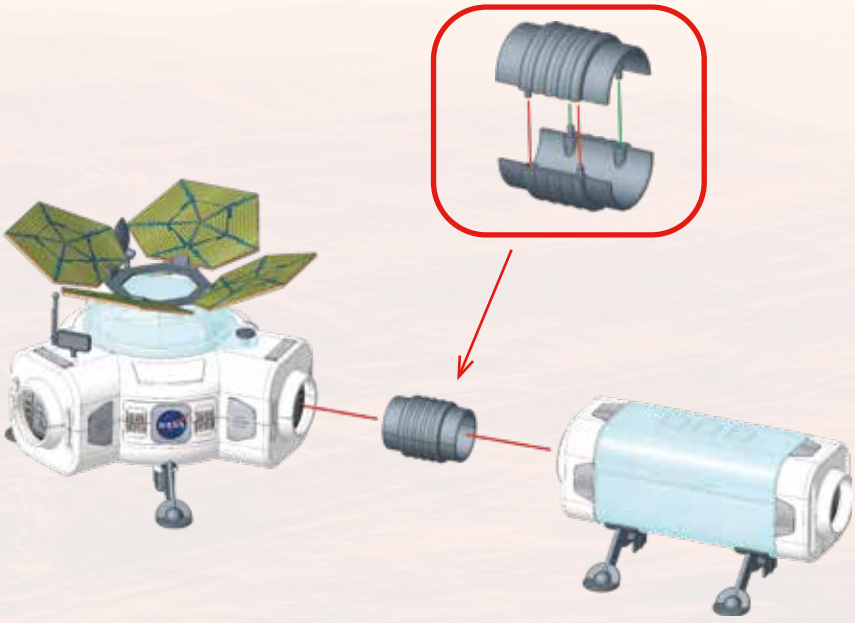


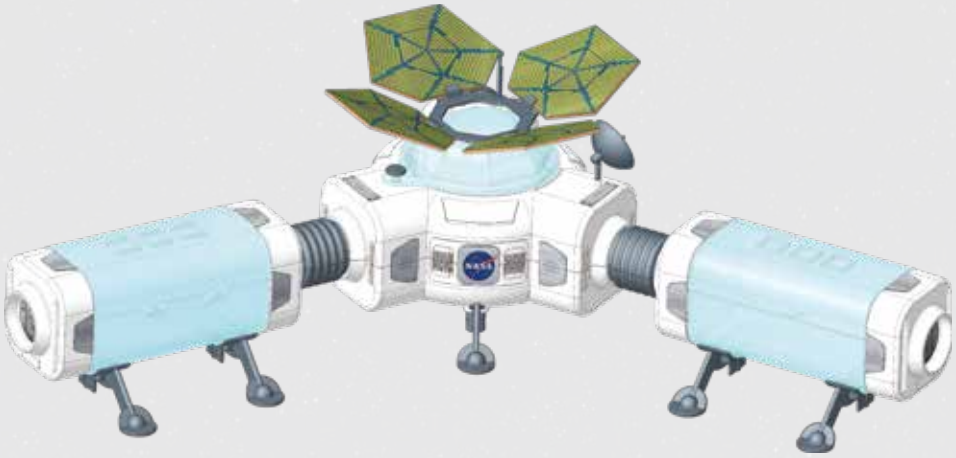
Apply the stickers to all the covers.

12

13



14 Create the second laboratory by repeating steps 9 to 12, then connect it to the base.



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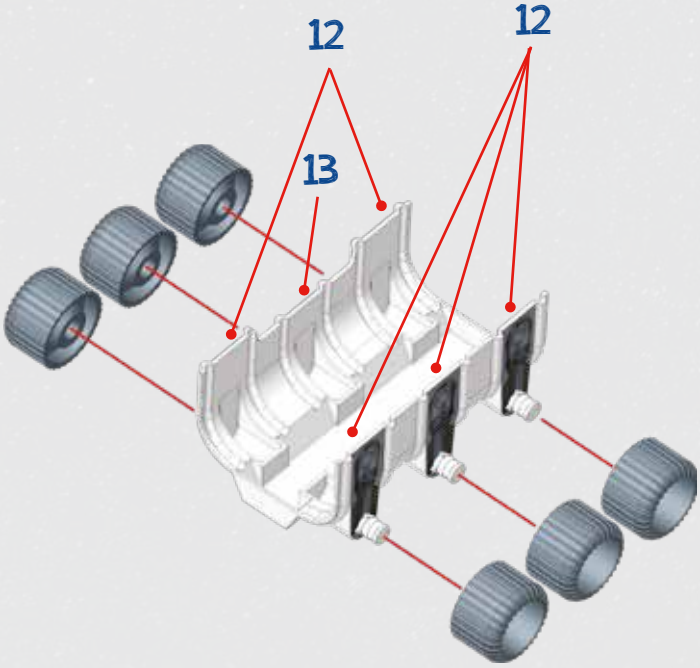

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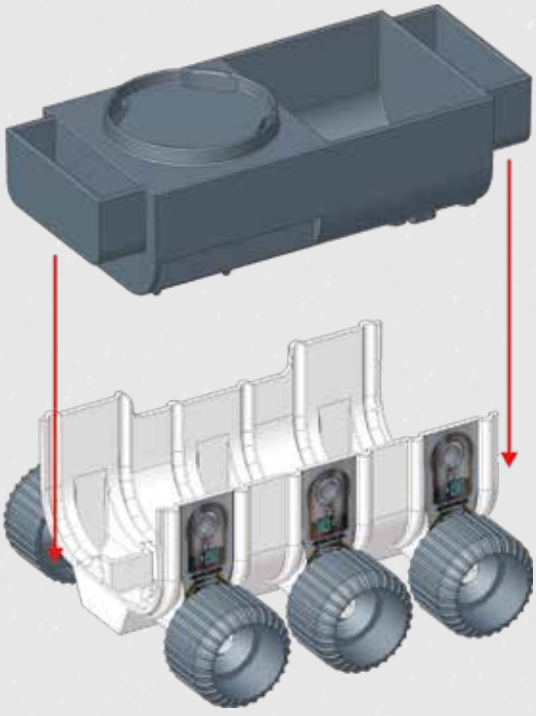

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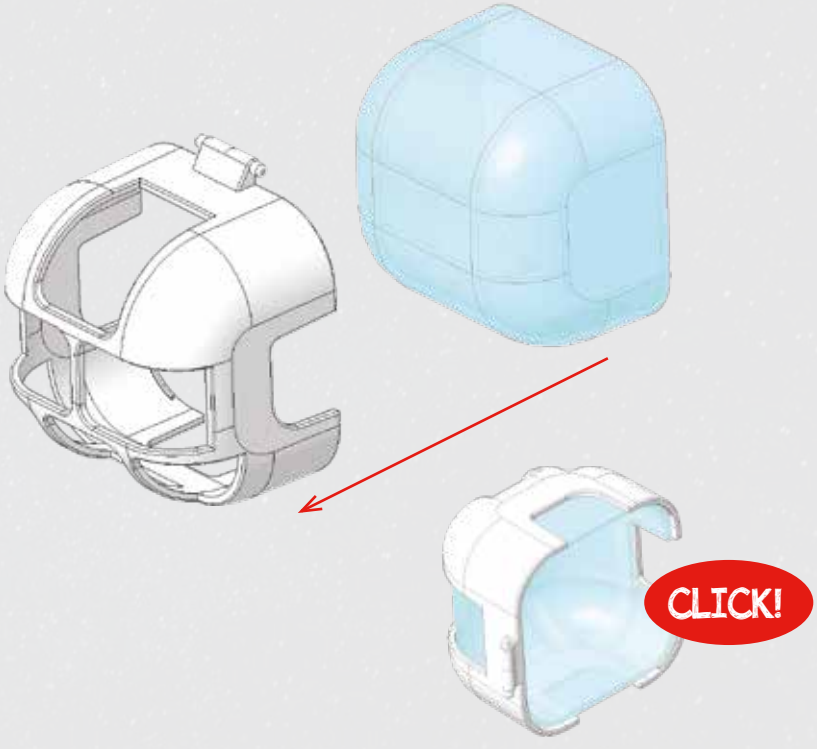

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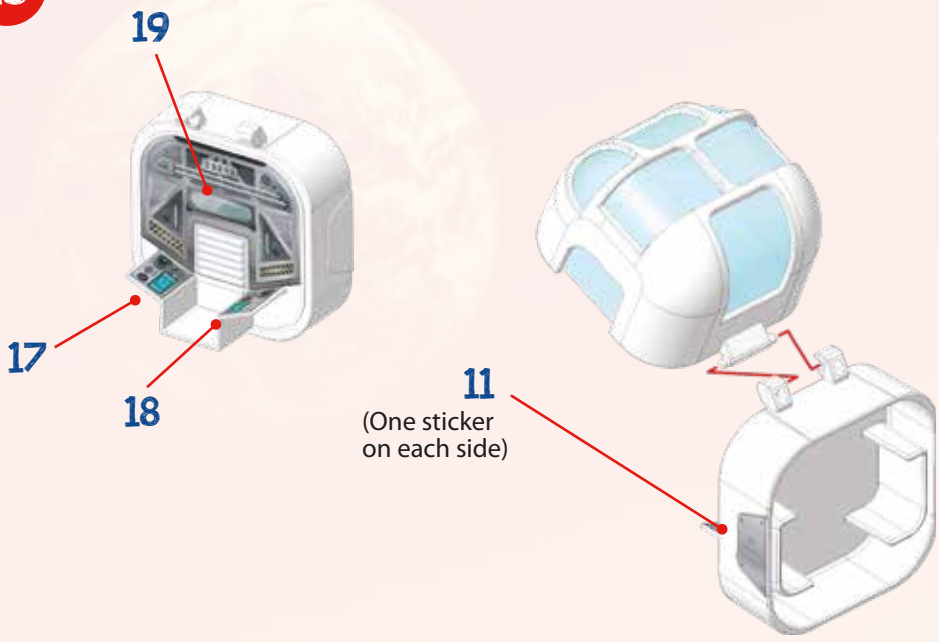

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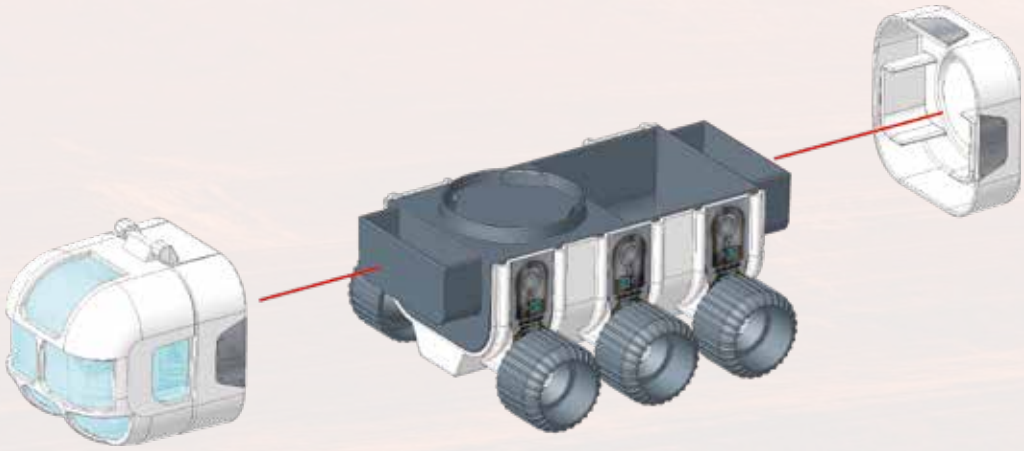

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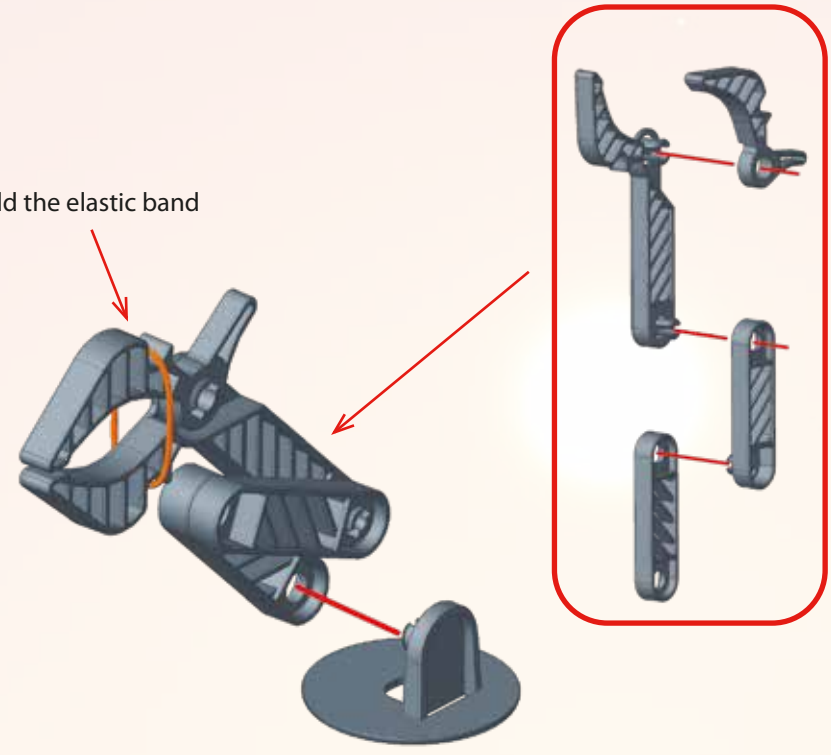
Add the elastic band



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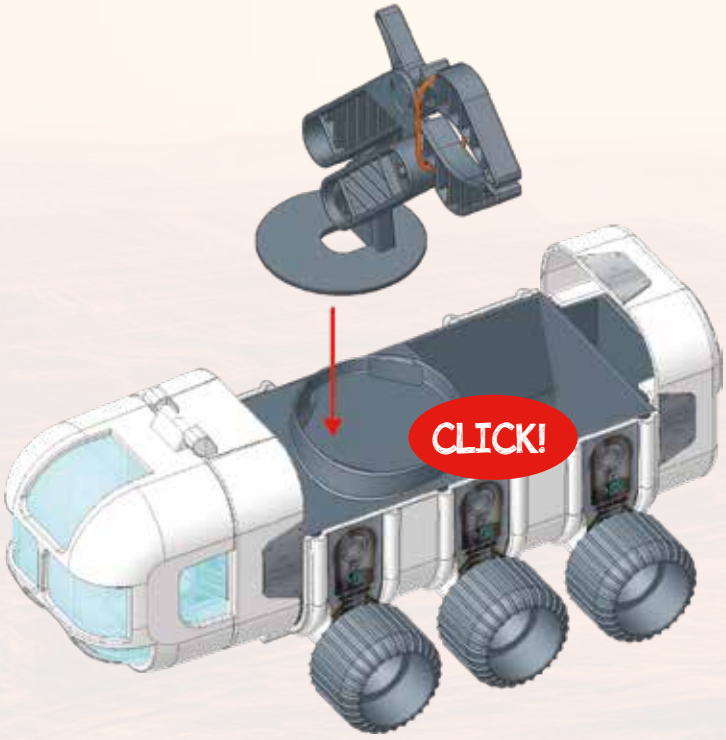

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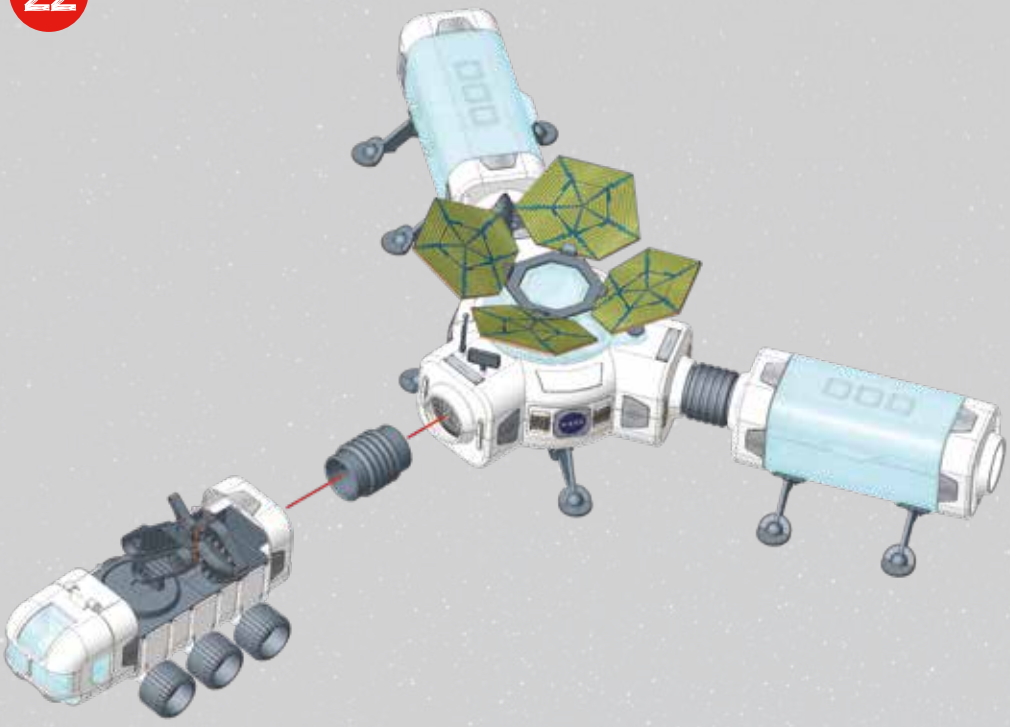

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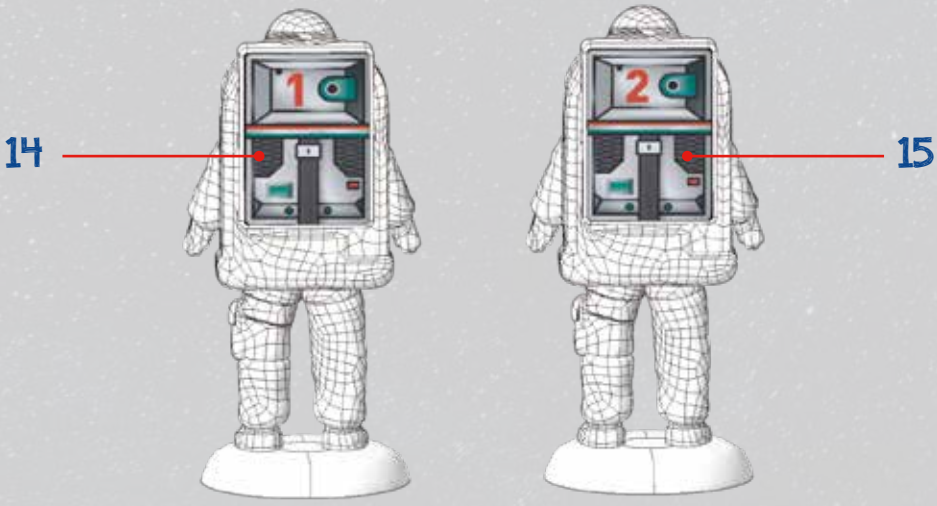
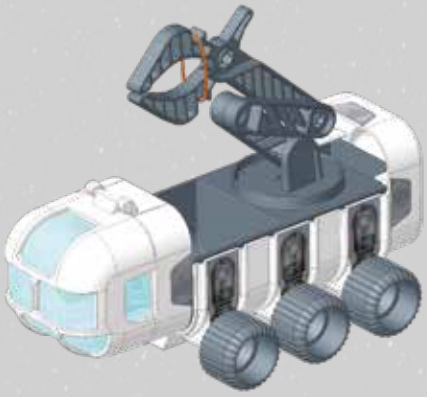


You can also use the rover to transport the laboratories! Remove the module with the mechanical arm and insert one of the laboratories into the space in the rover.



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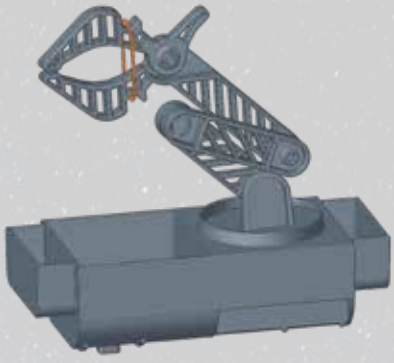

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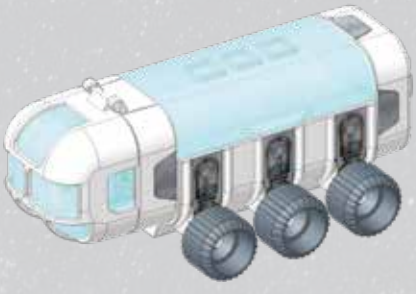

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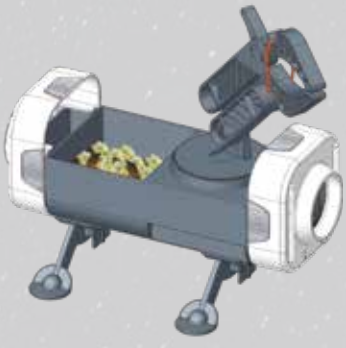
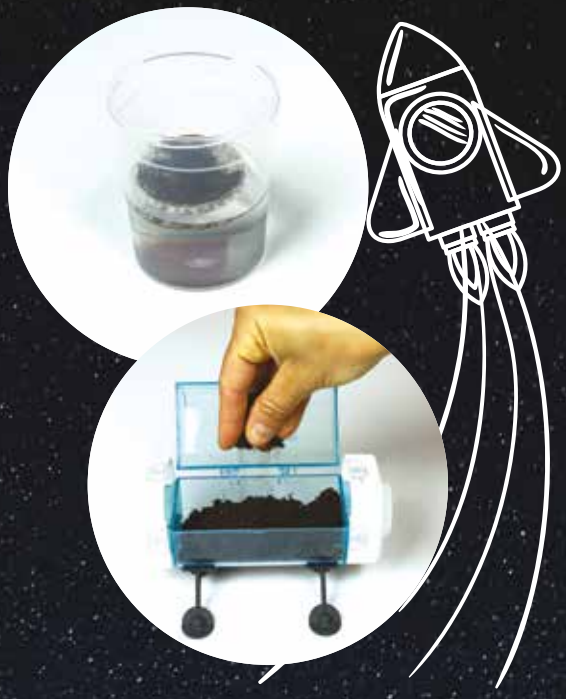


Using the mechanical arm of the rover, you can collect the rock samples included and transport them in the cargo bed.

ACTIVITY IN THE MARTIAN LAB

EXPERIMENT: GROW PLANTS

a) Prepare soil for the seeds



1) Put on a pair of plastic gloves found around the house!
Place a peat pellet in half a glass of water. It will slowly rehydrate and swell up.

2) Working on a piece of paper to avoid making a mess, remove the outer mesh and break up the peat in one of the two transparent module bases that will become the botanical laboratory for growing plants.

Continue with the other pellets until the transparent module base is full.

b) Sow the clover seeds

1) Open the seed sachet and tip some out, spreading them uniformly on the peat that you have prepared.

2) Do not cover them with more peat, but wet them with the pipette. Keep the space laboratory at a temperature of approximately 18–20°C and place it in natural light, watering it a little every day.

When the clover has grown enough that you can no longer close the laboratory, ask for the help of an adult to cut off the excess. You will see it grow back vigorously after a few days.

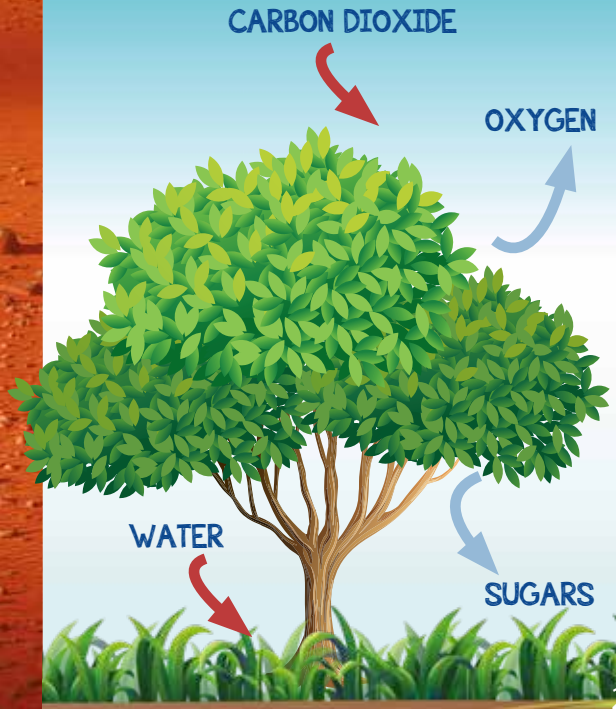
SCIENTIFIC NOTE
Germination starts when the seed swells up after absorbing water with breaking up of the integument (seed coating) and emergence of the root, then little leaves will soon appear.

HOW TO MAKE MARS INHABITABLE

The environment on Mars is without oxygen, having a very thin atmosphere composed of 95% carbon dioxide and a small quantity of nitrogen. Plants and vegetables are fundamental, but not the only resource, to create an environment suitable for the survival of living organisms and the production of food on the planet.

NOTE
During the seed-planting experiments, you can also use other seeds such as lentils, beans and peas. Remember to purchase them from specialist shops.

SCIENTIFIC KNOWLEDGE OF PLANTS



Photosynthesis

Plants on land produce the majority of oxygen present in the air around us. Plants growing in water also make an important contribution. A series of chemical reactions occur in green leaves referred to as **photosynthesis**, which transforms sunlight into sugars and oxygen, taking in carbon dioxide and water. Oxygen produced in this way can be used by almost all living beings.

THE REQUIREMENTS OF PLANTS: LIGHT, WATER, HEAT, OXYGEN AND SOIL

LIGHT

Light is essential for photosynthesis, the most important chemical process, which enables plants to develop and grow... Through photosynthesis in the chloroplasts, contained in plant cells, the plant can produce sugars and oxygen, utilising carbon dioxide and water.

WATER

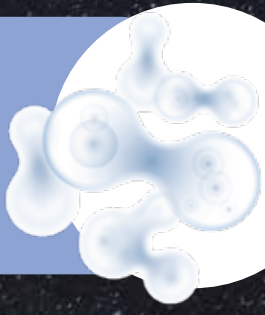
Water is essential for plants. It transports chemical substances from the soil to cells throughout the plant. It penetrates the roots and is released through the pores of the leaves.

HEAT

Very low or excessively high temperatures impede photosynthesis. Germination of seeds occurs at a temperature between 15°C and 25°C.

OXYGEN

Oxygen is required for cellular respiration, which occurs in all living organisms. Respiration means drawing energy from substances that reach the mitochondria within cells.



SOIL

Soil is the environment in which plants grow their roots and from which they absorb substances essential for their survival and growth (water and mineral salts).

EXPERIMENT: SET UP A COLONY OF ANTS IN "SPACE GEL"

PLEASE NOTE
This activity can be done after the winter, during the months when ants come up to the surface.
Collect ten ants, ideally from the same colony to avoid conflict between different groups, because the ant is a social animal.

On page 29, you will find some tips on how to catch ants without causing them any harm.
Remember to release them exactly where you found them at the end of the experiment!

a) Preparing the gel

***WARNING**: the bag with the preparation for gel contains 10 g of powder, which is enough to prepare the gel multiple times.*
THE PRESENCE OF AN ADULT IS NECESSARY!

1) Wash the transparent container to be filled with gel using soap and water and dry it thoroughly.

2) Measure out 150 ml of tap water with the graduated beaker and get an adult to pour it in a pan with a pouring spout that is suitable for use on the stove.

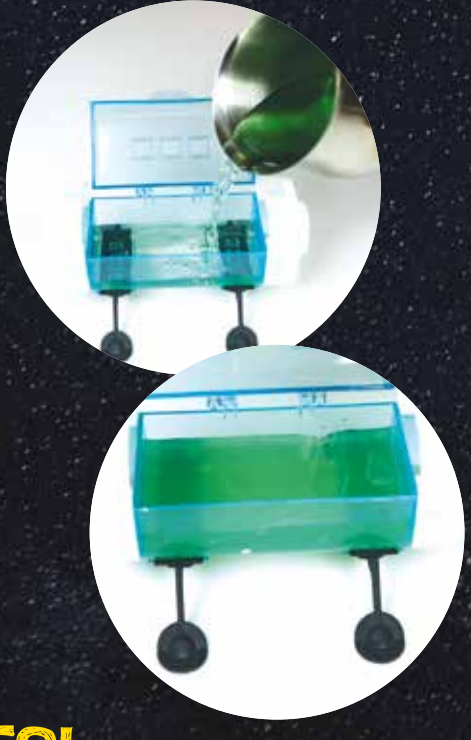
3) Remove 3.5 g of powder from the gel preparation bag, corresponding to 7 heaped teaspoons approximately. Pour the powder into the water, being careful not to wet the spatula. Finally, add one teaspoon of sugar from the kitchen.

4) Get an adult to mix the liquid solution with a metal spoon (not included in the kit), then ask them to heat the contents until it boils for 20–30 seconds.

NOTE
Put the powder left in the bag into the plastic beaker and close the lid tightly

WARNING: *use a low flame to boil the gel solution.*
ASK AN ADULT TO CAREFULLY PERFORM THE FOLLOWING OPERATION:

5) Wait around one minute for the solution to stop boiling and for the temperature to drop slightly, then pour it into the transparent container, which should not be moved until complete solidification of the liquid (let the gel cool completely, leaving the container open for approximately 10 hours).



WARNING: *The pan containing the gel must be kept out of the reach of small children and animals.*

6) Once the gel has solidified, dry any condensation droplets on the inner walls of the container with a paper towel.

NOW THE GEL LABORATORY IS READY FOR THE ANTS!

LOOKING FOR ANTS

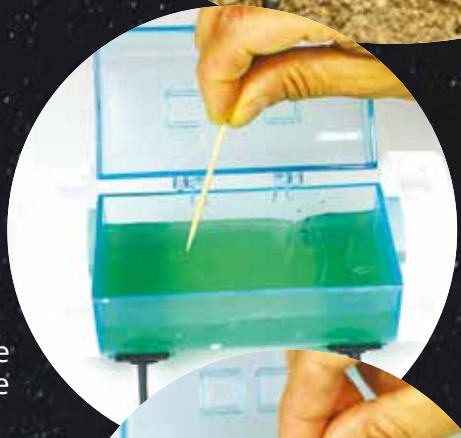
Find an ant nest in the garden or in a park.
Place some pieces of fruit peel or sprinkle a little sugar in the transparent beaker.
Place the beaker with the opening against the ground and wait for the ants to get in, then close the beaker with the lid.

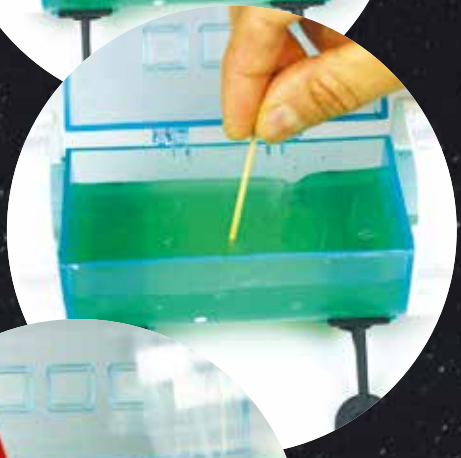
ASK AN ADULT TO HELP YOU!

b) Introduce the ants to the gel laboratory

1) Before introducing the ants to the gel laboratory, you should create a few holes 2–3 cm deep in the surface of the gel by using a toothpick. This will be the entrance of the tunnels.

2) With the help of an adult, gently transfer the pieces of fruit peel with the ants onto the surface of the solidified gel. Now, quickly close the cover of the container. You will remove the fruit peel later.





WARNING: *In any case, after around 15–20 days from when you start the activity using the ants, or before the appearance of any mould on the top of the gel, release the ants directly onto the ground in the site where you collected them and dispose of the gel with the organic waste.*

Disposal of gel

Wear a pair of plastic gloves found around the house to handle the waste material.

Using the plastic spatula, remove all of the gel and throw it in the organic waste.

Wash the transparent container with soap and water and rinse thoroughly, so that you can use it again.

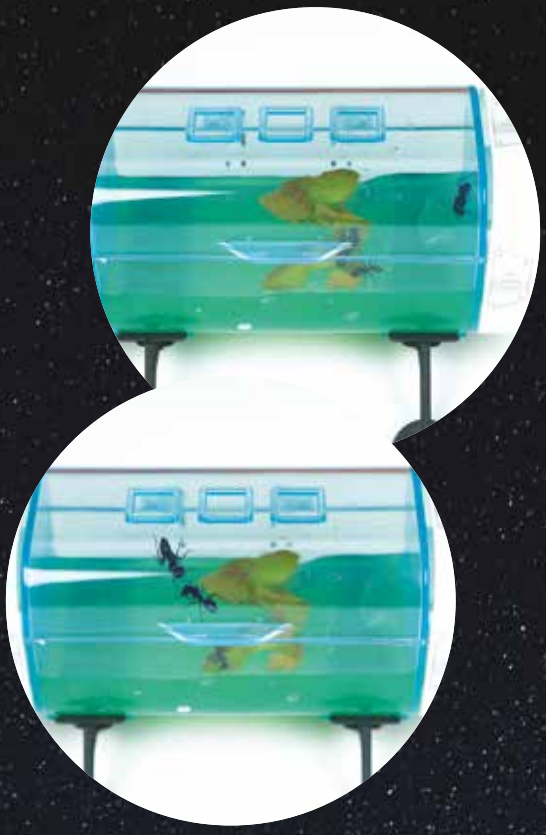
NOW START WATCHING THE ANTS!

The transparent gel provides a complete view of the little ant nest and allows you to observe the ants.

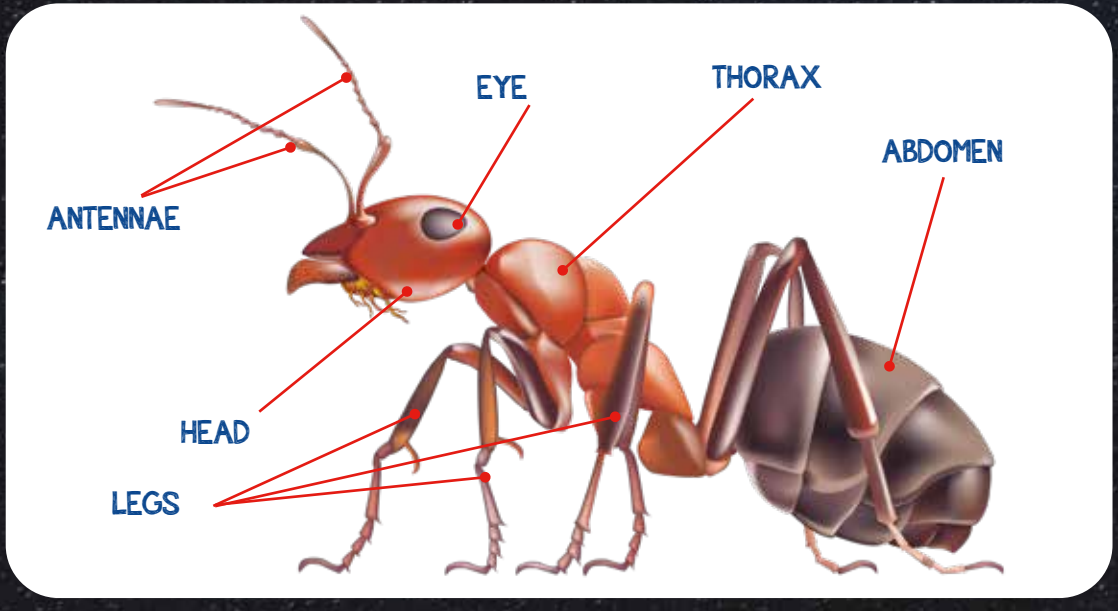
Observe how the ants start digging tunnels after a few hours, or sometimes after a couple of days. There are some ants that will not dig tunnels, even with the ideal conditions.

Remember not to insert any food or water in the gel, because it is already rich in nutrients and formulated to provide complete nutrition, including water. Remember to open the ant laboratory for a few seconds at least once a day. This will help refresh the air.

If you notice that the ants appear to be suffering during observation, free them immediately in the site where you collected them.



ANT ANATOMY



INTERESTING FACTS

1) WHAT TYPE OF ANIMAL IS THE ANT?
The ant belongs to the class of insects and lives socially in large numbers capable of building a nest and keeping it clean and operational.

2) HOW IS ANT SOCIETY STRUCTURED?
A colony contains individuals with different roles: one or more females that lay eggs (QUEEN ants), WORKERS with many different tasks to perform (searching for food, cleaning the nest, feeding larvae, etc.) and MALES with reproduction duties.

3) WHEN DID ANTS APPEAR ON THE EARTH?
Between 150 and 200 million years ago, when dinosaurs still roamed the planet.

4) HOW BIG CAN AN ANT BE?
The largest ant in the world is approximately 3 cm long.

5) WHICH ONES ARE FLYING ANTS?
These are the males and females (queens) responsible for sexual reproduction.

6) WHICH SENSE ORGANS ARE MOST DEVELOPED IN ANTS?
The sense of smell, via the antennae, which are also used to communicate.

7) HOW MANY ANTS CAN THERE BE IN A COLONY?
From tens to several millions.

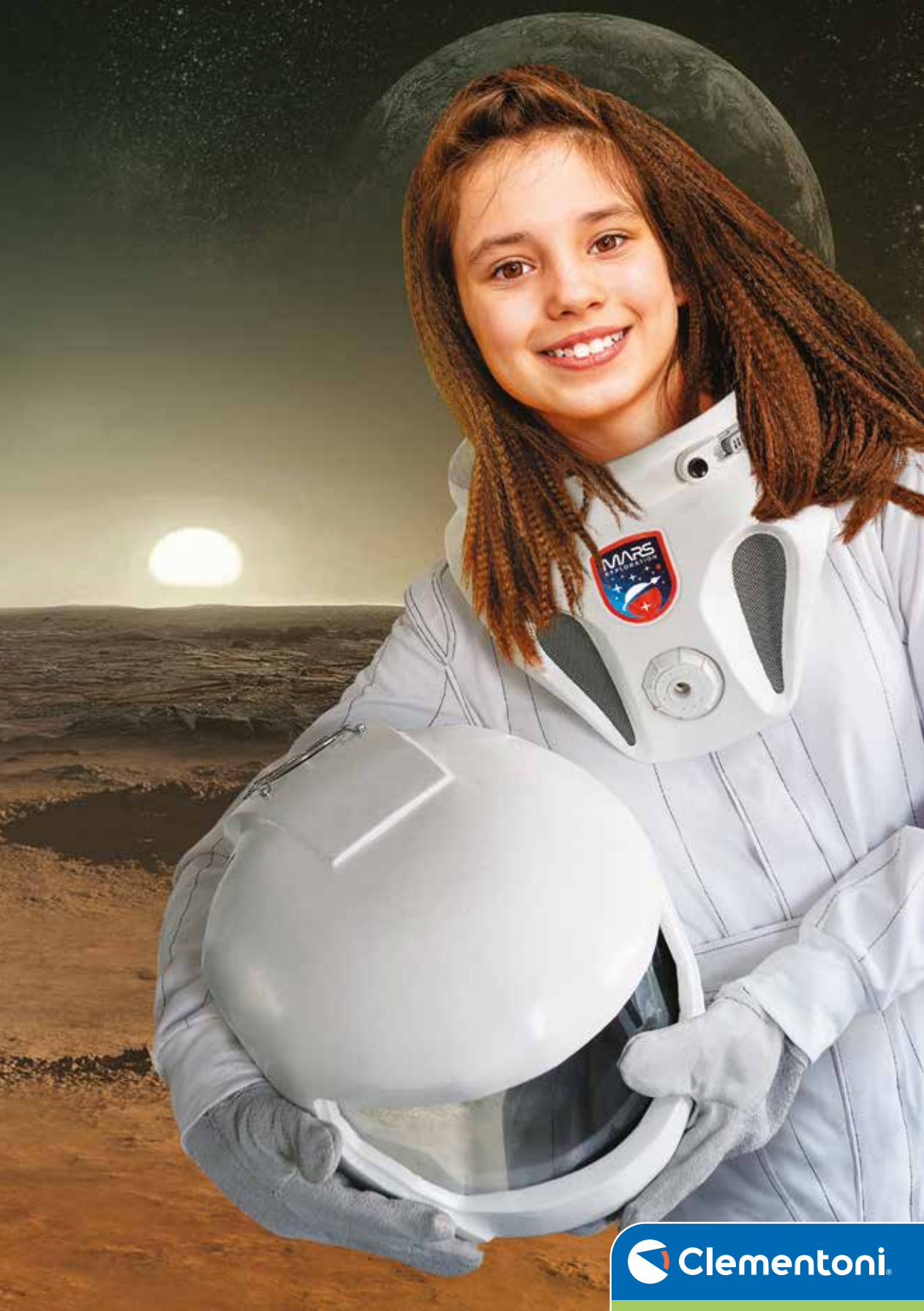
8) HOW LONG DO ANTS LIVE?
Generally, queens live 5–10 years or more, while males and workers only live for a few months.

9) HOW DO ANTS DEFEND THEMSELVES FROM ATTACKS?
Ants defend themselves by biting, stinging and spraying formic acid, an irritant substance.

10) HOW DEEP DOES AN ANT NEST EXTEND UNDERGROUND?
An ant nest can be up to a few metres deep.

11) ARE ANTS CLEAN ANIMALS?
Very much so! They clean their heads with their feet, and in the nest they have a specific area for gathering waste.

12) ARE ANTS STRONG?
Indeed! They can lift things tens of times their own body weight.



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