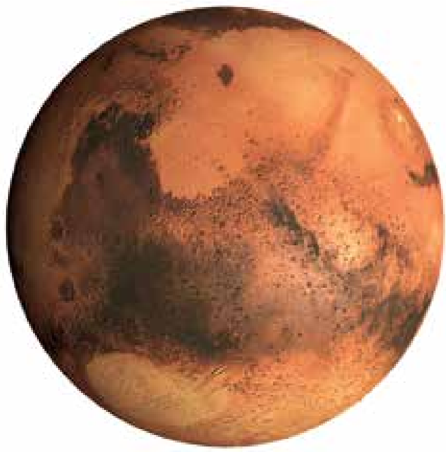
STORIES OF TOMORROW

Students Visions on the Future of Space Exploration



Mars in a nutshell

Trip to Mars

Explore Mars

Living on Mars

Assessment Tools

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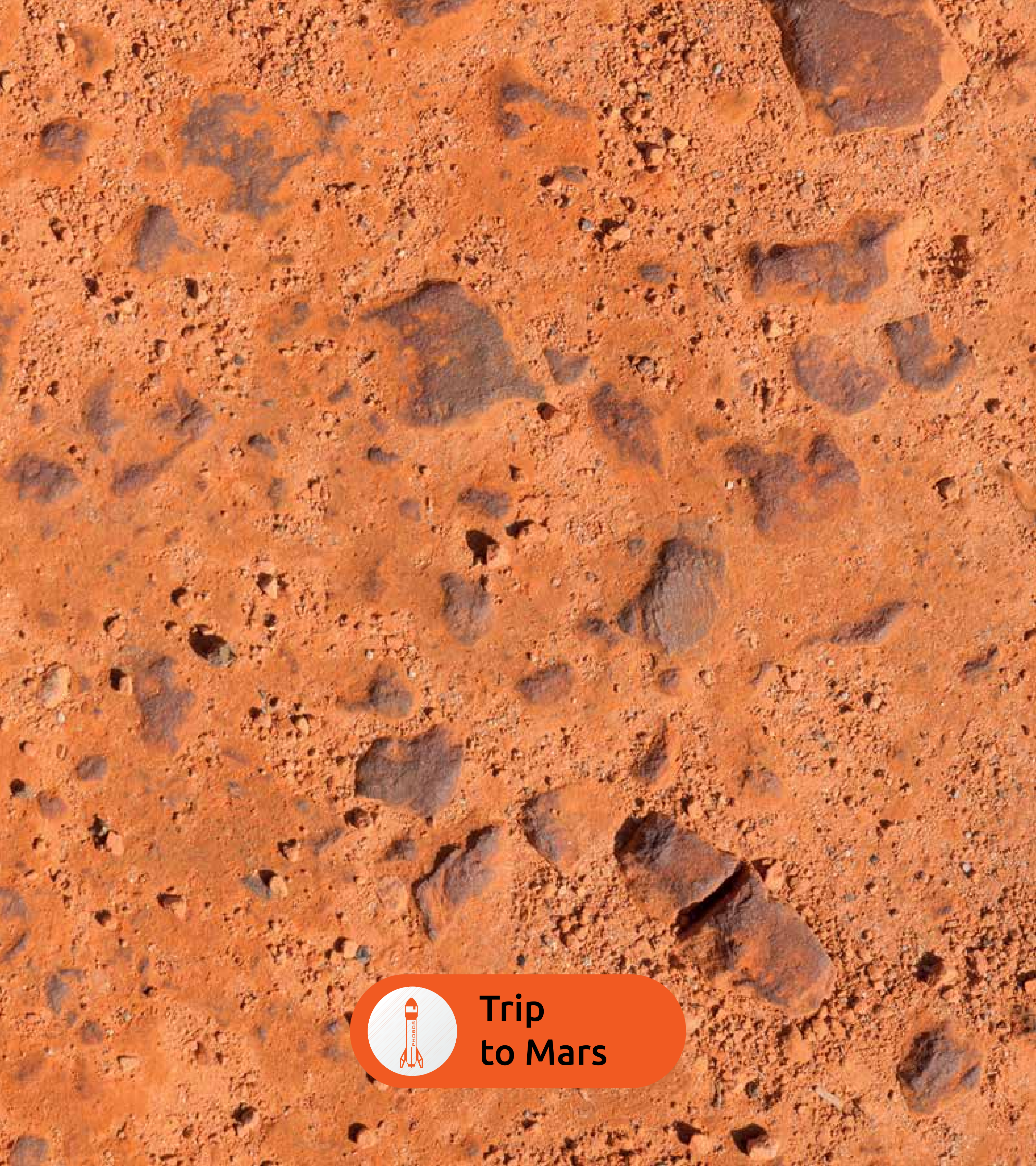
Trip
to Mars

STORIES OF TOMORROW

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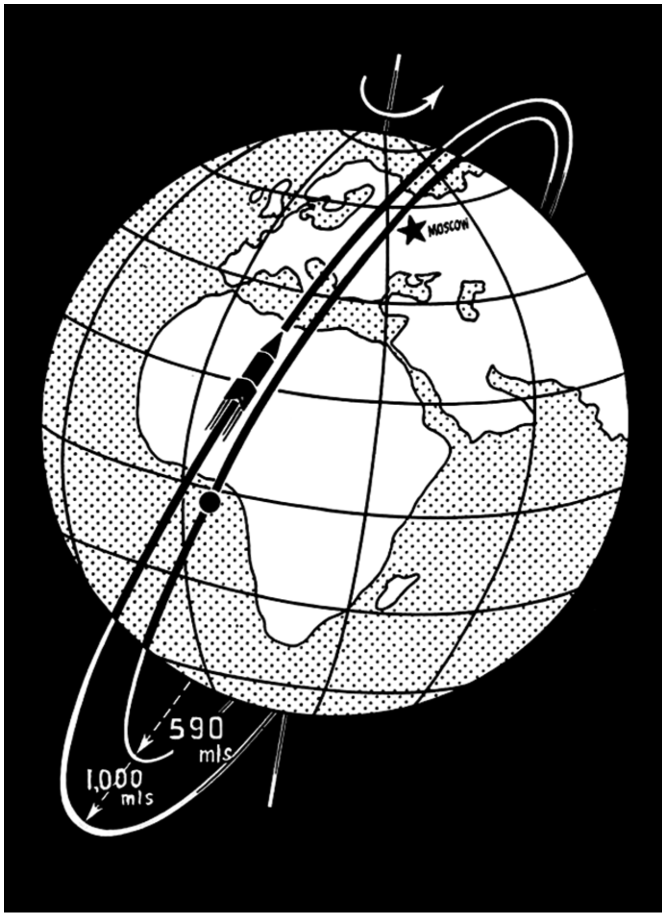
Trip to Mars: an overview

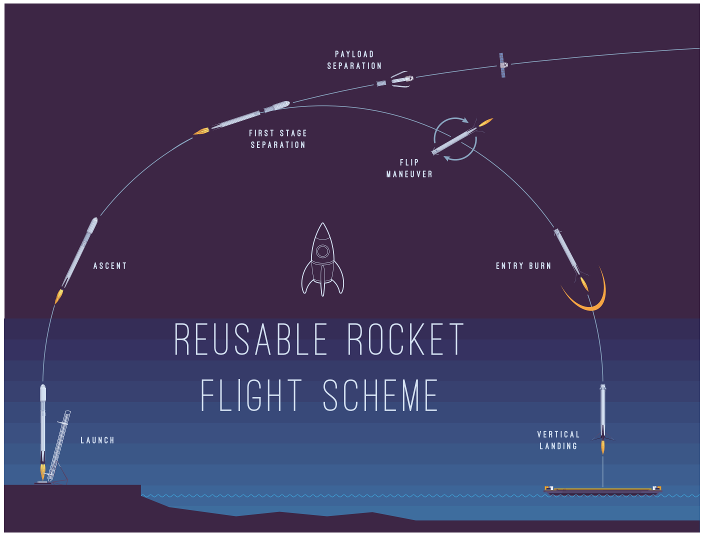
What happens when you throw something into the air? Depending on the force you employed, it will reach a certain height – and then fall back to the ground.
The Space Age began on October 4, 1957, when the USSR sent a small sphere into orbit around the Earth. What it meant was that, for the first time in History, someone had sent something up into the air, and it didn't fall immediately back (though it eventually did). In fact, Sputnik 1 did not escape the attraction of the Earth: it was going around the planet, in the firm grip of its gravitational field. The first man-made object to truly evade the grasp of Earth's gravity was the Soviet lunar probe Luna 1, in 1959. How did that come about? Well, they all went up mounted in rockets.



The principle of rocket propulsion was already known for centuries. Powder-propelled projectiles were used in medieval China, and soon became part of the arsenals of European armies.
At the beginning of the 20th century, the Russian Tsiolkovsky laid the foundations for turning what was a science-fiction dream into reality, proposing the use of rockets to travel in space, and explaining how that could work out.


Depiction of a rocket in Kyeser's Bellifortis (1405)

Others, such as the German Oberth and the American Goddard, strongly contributed to advance this idea, through theoretical and experimental work. During World War II, the German von Braun developed the world's first ballistic missile; with the conflict over, he went to the USA and led the evolution of the V2 flying bomb into what would become a space launcher. He later became the great force behind the American space program.
When a rocket is launched, it generally takes either a manned or cargo vessel to Earth orbit, or a probe that will depart Earth orbit to reach interplanetary space. If you have ever watched a rocket launch, you may have noticed that the rocket does not, indeed, go straight up all the way.



After reaching a given altitude, it turns to follow a trajectory that ends up in a circular path around the Earth: orbit. To do this, though, the rocket needs to achieve a certain velocity that allows it (and its payload) to counter gravity and drag. This is about 7-8 km/s. This normally requires the use of a rocket with several stages: separated parts that each has its own engines and fuel deposits, that impart further acceleration to the vehicle. The usual fate of the first stages is falling back to Earth – but only now are we beginning to see a controlled return that makes reuse really possible.
There is a reason for the fact that many probes to the planets are not directly sent on their way from the surface of the Earth, but first enter into orbit and only then leave this condition and proceed to their targets.
The escape velocity, or the velocity needed to escape from the gravitational attraction of the Earth, is lower on that orbital location, far from the bulk of the Earth; also, the mass to be propelled is much smaller, and so a much smaller quantity (mass) of fuel is needed. Because there is this rule that applies to rockets: the more mass you want to send up, the more fuel you need, and the larger and heavier your launcher will be.
Another factor to take into consideration is, of course, the shape of the rocket. All rockets share a basic design: a long cylinder topped by a cone. The space shuttle didn't, but that was only because it had to return to the Earth and so had to include surfaces (wings) that allowed it to glide through the atmosphere and touch down as a plane. Could a brick-shape be sent into space? Yes, but it would take much more energy to break through the atmospheric drag. It would not have the aerodynamic efficiency of rockets and planes.
In science fiction movies we constantly see spaceships that fly through alien atmospheres with no problems; but our current reality, using chemically-powered vehicles, would simply not allow it.
Thus, if one considers the possibility of sending a large number of humans to Mars, it would be far more logical to build a large transit ship in orbit (setting aside all the problems related to flying such a huge vehicle through the terrestrial atmosphere) and ferry the crew and colonists aboard, in several launches of smaller capsules. Remember that, other than people, this ship would have to carry air, water, food, and many other supplies to help starting a colony on another planet. Of course, there is the possibility of sending other ships with supplies – cargo vessels, basically. But

the ship taking the human cargo would still need to carry supplies for the long trip.
The human experience in space is rather limited. There rarely have been more than ten people simultaneously in space (actually, thirteen was the maximum). The number of people that can be called astronauts is a little over 500, but only 24 ever went farther than low Earth orbit, and only 12 have walked on another planetary body (the Moon). The first astronaut (or cosmonaut, according to the accepted designation) was Yuri Gagarin, who flew several orbits around the Earth on April 12, 1961. The astronauts and cosmonauts of the time were recruited among the elite of military pilots; people who were used to test-fly new machines and had the nerves to sit atop a cylinder full of stuff ready to explode, and be sent into the heavens. A few years later, amidst what was a race to land people on the Moon, NASA admitted the first non-pilots into the astronaut corps (though they still had to become pilots and fly long hours to qualify as astronauts). One of them even walked on the Moon, proving that you didn't need to have a military pilot background to be an astronaut.

© NASA

Nowadays, astronauts have widely diverse backgrounds, and find the opportunities to employ their skills in missions to the International Space Station. In fact, after the end of the Moon race in 1969 and the final Apollo missions, Humanity retired to the neighborhood of the Earth. Several space habitats and stations, Russian, American and International, have orbited the Earth and been occupied for long periods, on occasion. Some people spent around one year in space.

But, most importantly, there are thousands of people working in a myriad of functions to help send people and machines up to space. They are not only engineers, technicians, and scientists; they are clerks, cooks and lawyers, they are doctors, teachers and historians. Practically every profession can be linked to space! And when it comes to selecting people to establish a permanent colony on Mars, there will be a place for everyone – especially if that colony becomes a reality after extensive exploration, and its main purpose is not to improve on the knowledge of the planet, but to provide a new home for the human kind.

Humanity evolved on Earth, and is perfectly adapted to living on its surface, occupying pretty much each and every habitat that allows for survival. Space is a different matter. Of course, direct exposition to space conditions would result in sudden and rapid death. Astronauts have left the relative safety of their vehicles on several occasions, and for that they have dressed up in spacesuits. These are garments in multiple layers that insulate and protect the person from the vacuum and temperature extremes of space.

They have evolved through time, using new materials, allowing for better movement, and even becoming autonomous from the vehicle. When inside a pressurized vehicle, such as the International Space Station, the crew members do not wear these heavy suits – they use light garments such as you would use on a summer day on Earth.

So far, there has been no need for a different type of suit, one that is adapted to the surface of Mars, for instance – but research into the matter is currently being done. A planetary suit does not need the same amount of protection – there is some atmospheric pressure, and not a vacuum, for instance; it should be less bulky, lighter, and provide autonomous and free movement; furthermore, it should be easy to get into and out of.

But there are major problems with prolonged stays in space. The micro-gravity environment is far from ideal for the human bones and muscles. There is a proven loss of strength and bone density, even when astronauts follow exercise programs – have you ever noticed that, when returning to Earth after a couple of months in space, astronauts have to be carried and placed in cushioned chairs?

The other major physical risk is the radiation environment; out of the shell provided by the terrestrial magnetic field and the ozone layer, the levels of cosmic and solar radiation are much higher (and solar flares can pose a definite threat). One other risk comes from possible impacts with meteoroids (natural and man-made).

All these dangers have to be taken into account when considering a trip to Mars. Distances in space are immense, and a mission to Mars would require a transit time of at least six months. A quicker journey, adapting a direct trajectory instead of what is the most common mission plan (called a transfer orbit) would require enormous amounts of energy. The less expensive (energy-wise) trips become possible at approximately two-year intervals, during a couple of months.

So, huge efforts would have to be made to provide conditions that could help prevent at least some of these dangers. Artificial gravity could be provided by carrousel

modules in the ship, that is, wheels that would spin and thus generate a centrifugal force that could replicate the impression of gravity.
The radiation-related problems are more complicated, since shielding would require the use of heavy materials; one possible solution under study is for the ship to generate its own magnetic field, thus providing an amount of protection from outside radiation.
Then there are the problems related to having a group of people living together in a confined space for such a long time. Of course, this would be minimized if the group traveling to Mars was constituted by a significant number of colonists. But there would probably occur psychological problems – no matter how prepared someone would claim to be to go live in another planet, the reality of it could reveal itself rather problematic. Humans have a link to the Earth that has never been tested in that way.
Still, we can always remember the words of Tsiolkovsy, and find motivation in them:
"Earth is the cradle of Humanity, but one cannot live in a cradle forever".

12:30
18%
24%
88%
35%
24°C
12:30
MISSION CONTROL CENTER

Activities

1. Design the spacesuit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Overview

Students analyze conditions on mars to evaluate and establish criteria for designing spacesuit features and then draw and label a spacesuit design. (arts/stem)

1) Design arts (parts that make up the spacesuit –their usefulness)
2) Visual arts (design of spacesuit and/or considering other options besides spacesuits)
3) Hands-on experimentation (what materials are good for developing a spacesuit)

Objectives

Students will:

Research the environment of Mars. Learn about the planet Mars and the challenges that the martian environment will pose to the first community there. These conditions will require special protective clothing. Identify and analyze necessary spacesuit features for Mars. Make decisions and conceptualize about necessary spacesuit features for Mars. Use criteria to determine whether a spacesuit offers enough protection on mars. Learn about form, proportion, shape, the human skeleton and simplification. Explore various sketching styles and the relationship between techniques and ideas. Consider how clothing impacts our daily life. Make hypothesis, test and experiment with different fabrics and colors that could provide insulation for the different layers of the proposed spacesuit designs. Enjoy and be able to challenges requiring them to apply knowledge in nonroutine ways. Understand key principles and relationships within a content area and organize information in a conceptual framework. Learn, remember and recall facts relevant to an area. Learn and can apply theories relevant to a content area. Know and be able to use the language specific to a content area. Apply facts to real word situations. Be familiar with and be able to use effectively the tools and techniques specific to a content area. Evaluate, integrate and critically analyze multiple sources of information. Structure information and data in meaningful way. Formulate problems and generate hypotheses. Identify data and information needed to solve a problem. Reason and construct justifiable arguments in support of a hypothesis. Collaborate with others to complete tasks and solve problems successfully.

Tools
Online exploration / Q&A / Fast Facts / Myths vs realities / the news

2. Rocket

Overview
Students study how basic rocket processes are applied to space flight. They design and built a rocket for the trip to mars. They choose the proper rocket for the trip.
(visual arts / 3D design / hands-on experimentation / stem)

Objectives

Students will:

Understand how real rockets propel themselves into space. Demonstrate the ability to conduct an experiment, analyze and interpret the results. Analyze and evaluate evidence, arguments, claims and beliefs. Take decisions based on facts. Enjoy and be able to challenges requiring them to apply knowledge in nonroutine ways. Learn, remember and recall facts relevant to an area. Learn and can apply theories relevant to a content area. Apply facts to real word situations. Be familiar with and be able to use effectively the tools and techniques specific to a content area. Evaluate, integrate and critically analyze multiple sources of information. Structure information and data in meaningful way. Formulate problems and generate hypotheses. Identify data and information needed to solve a problem. Reason and construct justifiable arguments in support of a hypothesis. Collaborate with others to complete tasks and solve problems successfully.

Tools

Online exploration / Q&A / Fast Facts / Myths vs realities / the news / 3d design-printer

3. Train like an astronaut

Overview
Students participate in the Train Like an Astronaut activities. They will take video of their training and/or they will perform how is astronaut's life. (performing arts/movie)
Objectives
Students will:
Exercise and understand more about how physical activity and nutrition affect the human body by conducting a set of hands-on explorations. Play and make a movie. Learn to communicate and collaborate with others. Enjoy and be able to challenges requiring them to apply knowledge in nonroutine ways. Be familiar with and be able to use effectively the tools and techniques specific to a content area. Know and be able to use the language specific to a content area. Collaborate with others to complete tasks and solve problems successfully.

Tools
Q&A / Fast Facts / Myths vs realities / the news / video / comic &storyboard creator

4. Working in weightless conditions

Overview

An astronaut who had once been on a spacecraft repair mission has jokingly said in an interview that working in weightless conditions is like changing a small fuse of your car's battery with ski gloves on, and all of this while standing on a roller skate. Students play a game to understand the difficulties we encounter when working in a different environment than the one we are used to and naturally equipped for. The game is executed by two teams: one working under the constrains of "weightlessness" (mask, gloves, roller blades) and the other in normal earth-like conditions. (performing arts, hands-on)

Objectives

Students will:

Understand the importance of team work, the difficulties of communicating (in space, but also in daily life), the "astronaut" team's feeling before, during and after working in space, and the concept of how, the human body adapts to life on earth. Work as part of a group. Collaborate with others to complete a task. Enjoy and be able to challenges requiring them to apply knowledge in nonroutine ways. Be familiar with and be able to use effectively the tools and techniques specific to a content area. Collaborate with others to complete tasks and solve problems successfully. Communicate and incorporate multiple points of view to meet group goals.

Tools

Q&A / the news / video / comic &storyboard creator

5. Research in weightless conditions

Overview

The results from plant research in space may lead to an extended use of plants onboard spacecraft. For example, to regulate the level of gases in the cabin air and to recycle water. Students carry out a plant experiment to find out what influences its growth and how plants behave under different conditions. (hands-on experimentation)

Objectives

Students will:

Demonstrate the ability to conduct an experiment, analyze and interpret the results. Formulate problem and generate hypotheses. Apply different ideas specific to a content area to gather necessary data. Enjoy and be able to challenges requiring them to apply knowledge in


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nonroutine ways. Understand key principles and relationships within a content area and organize information in a conceptual framework. Learn, remember and recall facts relevant to an area. Learn and can apply theories relevant to a content area. Apply facts to real word situations. Be familiar with and be able to use effectively the tools and techniques specific to a content area. Evaluate, integrate and critically analyze multiple sources of information. Structure information and data in meaningful way. Formulate problems and generate hypotheses. Identify data and information needed to solve a problem. Reason and construct justifiable arguments in support of a hypothesis.

Tools
Online exploration / Q&A / Fast Facts / the news

6. Living in weightless conditions for a long time

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Overview

Living on board. Is this an ordinary living? What about eating, sleeping, washing your hair and going to the toilet? Students present how life would be on a long trip to mars. (performing arts/language arts/movie)

Objectives

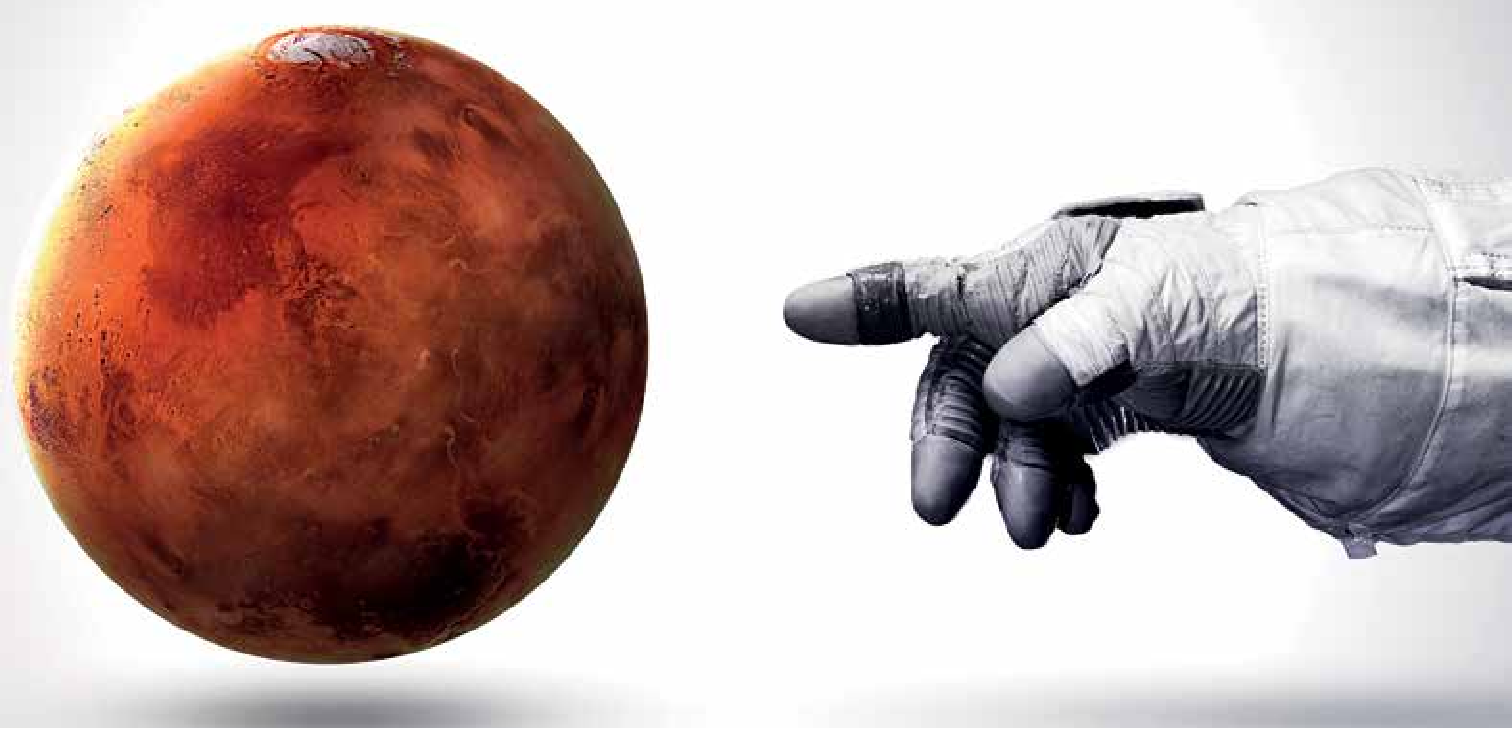
Students will:

Research the life on board the ISS and to weightless conditions. Make a list about how they spent their day and a checklist of what they would have to bring with them to a trip to mars. They write about their days on board in an astronaut diary. Create a cartoon/story/movie showing a day on board the spacecraft. Enjoy and apply knowledge in nonroutine ways. Communicate concepts to others in oral presentation. Enjoy and be able to challenges requiring them to apply knowledge in nonroutine ways. Be familiar with and be able to use effectively the tools and techniques specific to a content area. Know and be able to use the language specific to a content area. Collaborate with others to complete tasks and solve problems successfully. Communicate concepts to others in written and oral presentations.

Tools

Online exploration / Q&A / Fast Facts / Myths vs realities / the news / video / comic & storyboard creator

http://www.storiesoftomorrow.eu/



The Stories of Tomorrow project is financed by the European Commission within the Horizon 2020 Programme.