TEACHER BOOKLET
From Key Stage 2 (7 years old, primary school) to Year 11 (16 years old, secondary school), activities for the classroom: science, oral expression, history, languages, etc.

RENDEZ-VOUS AVEC LA LUNE

ACTIVITY SHEETS

CNES CENTRE NATIONAL D'ÉTUDES SPATIALES
Cité de l'espace TOULOUSE

Design - Production: Caroline Carissoni, Clément Debeir - Agence SapienSapienS. **Written by:** Caroline Carissoni. **Graphics:** CNES Multimedia Division - Design Marine Sangouard, Production: Karine Priselkow. **Artwork:** Agence SapienSapienS - Claire Burgain, Caroline Carissoni, Clément Debeir. Société Photon - Marie-Claire Fontebasso. **Printed by:** CNES multimedia division. Printed in 2018.

Acknowledgements: Francis Rocard, Head of Solar System Exploration Programmes, CNES; Serge Gracieux, Exhibitions Department, Cité de l'Espace; Pierre Ferrand, Life and Earth Sciences teacher, Project Leader for CNES; Jean-Paul Castro, Physics and Chemistry teacher, Project Leader at the Cité de l'Espace; Karine Bichet-Ramon,Project Leader for Scientific, Technical and Industrial Culture, Toulouse Education Authority, member of the IRES "Science and Media" group.

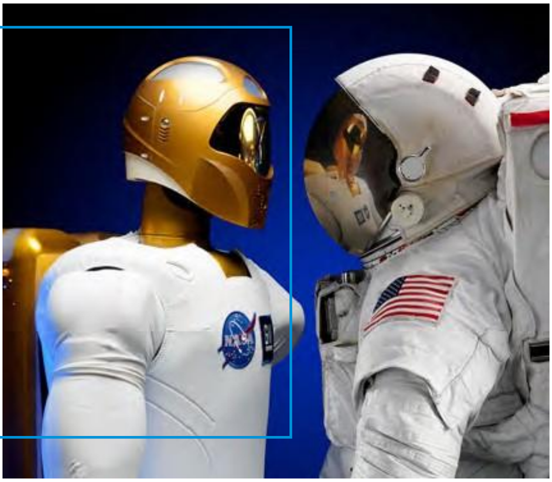
This document is co-published by the CNES Communication Department - Youth Education Unit) *education.jeunesse@cnes.fr* and the Cité de l'Espace Education and Scientific Mediation Department.

cnes
CENTRE NATIONAL D'ETUDES SPATIALES

Cité de l'espace
TOULOUSE

TABLE OF CONTENTS

Sheet 1
debate
Humans or robots, who should explore space?



OBJECTIVES
- Organise your thoughts, build and present arguments
- Develop your listening skills and ability to analyse
- Reflect on Humans' place in their immediate and more distant environment
- Discover and reflect on new technological developments
- Understand the solar system and the cosmic environment

INTRODUCTION
Advances are constantly being made in robotics (the design and manufacture of autonomous machines) and artificial intelligence (machines that are capable of imitating a form of human intelligence, i.e. to learn, reason and adapt), thus making it possible to explore more distant locations with greater precision, while reducing costs and increasing safety in comparison with human exploration. However, humankind still needs to explore new extraterrestrial worlds to develop its knowledge, quench its thirst for exploration and find new resources, or even new places to live.
Within this context, what type of space exploration should be prioritized? Automated flights or manned flights?

PROCEDURE

PHASE 1

Setting up the debate

› Prepare for the debate by reading texts or watching videos about the role of robots in space exploration and the constraints of manned spaceflight.
For example:
- File "*Les robots à l'assaut de l'espace*" (Robots in space) *https://jeunes.cnes.fr/fr/web/CNES-Jeunes-en/11812-les-robots-du-futur.php*
- Video "Thomas Pesquet explains the dangers of the ISS" *https://spacegate.cnes.fr/fr/video-thomas-pesquet-et-les-dangers-de-liss*

› Set out the aspects of the debate on "Humans or robots, who should explore space?"
Organize the structure of the debate:
Create 4 groups, each one defending a certain point of view, then ask each group to list the arguments it will use to defend its position. If necessary, prepare lists of arguments that you can give them to overcome certain difficulties due to a lack of knowledge about the topic (which is to be expected).

Group 1: experts in manned space flights
They defend human exploration, which responds to people's need to push beyond their intellectual and physical limits. For them, artificial intelligence can neither replace nor surpass human intelligence. For example, during the Apollo missions, it was the geologist Harrison Schmitt that brought back the most interesting rock samples. A robot is much slower than a human being at carrying out tasks that have been programmed by Humans and, in the event of an unexpected incident, a human being reacts much more quickly.
Exploring the Universe is essential for improving our understanding of the Earth and for preparing the colonization of other worlds, in anticipation of the day our planet will disappear or become uninhabitable. This has to involve the use of robots, as complementary allies to humans.

Group 2: robotics experts
They are convinced that technical progress is speeding up and will very quickly give rise to a new generation of robots capable of operating autonomously. Perhaps we will be able to build robot-avatars, into which we can project our thoughts, so that we can explore places that are inaccessible to humans? Only robots are capable of reaching very distant objects and operating in extremely hostile environments. For example, the Philae lander managed to land on a comet after a 10-year journey.
The equipment needed to ensure the safety of human beings is far more complex and expensive.

Group 3: diplomats in charge of international relations
They highlight the cooperation involved in space exploration, in both manned and unmanned space missions.
European countries cannot finance these missions on their own, and projects are more effective when carried out by a several partners working together. A good example of this cooperation is the International Space Station (ISS), which has existed for 20 years and was assembled by the Americans, Canadians, Europeans, Russians and Japanese. Manned missions facilitate mutual understanding, and we need to learn to work with the new players in the space sector, notably India and China. It is important to ensure public-sector players remain committed to projects that are of general interest to humankind, notably in the face of the emergence of private-sector players such as the billionaire Elon Musk and his plan to colonise Mars, possibly driven by commercial interests.

Group 4: astronauts
They believe that international manned missions are a means of guaranteeing peaceful exploration that is not dependent on individual economic interests. These qualities are all the more important given that one day humankind will have to find new resources or settle elsewhere. By going into space, Humans realise just how valuable and fragile the Earth is, and how much it needs to be protected. Robots, on the other hand, do not have that awareness, and using robots deprives humans of the physical and intellectual experiences they need to adapt to a new environment. Astronauts are also directly involved in scientific experiments that are useful to everyone (notably in the field of health).

PHASE 2

Starting the debate

› Give the floor to each group in turn (or each group's spokesperson if relevant) so that they can present their arguments.

› Take the floor between each presentation and summarize the key points of each line of reasoning.

› When each group has presented their arguments, suggest discussing the key points raised.
Encourage each group to go beyond their initial comments and add to them in order to support their counter-arguments. If necessary, provide additional information or ideas.

› Finally, ask each group to present its closing arguments and conclusions. You may also draft a written report about how the debate went (respecting the speakers' time, physical attitude, depth of the argument, ease or difficulty in expressing oneself) and the key arguments that stood out (what conclusion should be drawn?) Has anyone changed their point of view? Could new scientific and technical advances lead to a shift in positions? etc.)

TO TAKE THINGS FURTHER

The degree of complexity of the arguments that are learned and presented will vary according to students' levels and competences.
Certain topics can be explored in greater depth by expanding the scope of the debate to the evolution and place of machines in society, the adaptability of Humans and their impact on the environment, knowledge of our solar system and international cooperation, or the various international players involved in space research.

Ethical issues can also be addressed, for example issues linked to projects involving a combination of public and private funds, or the creation and application of international regulations concerning space.

The discussions could also address developments in artificial intelligence and how this could open the door to new forms of exploration (either as an extension to human exploration or as a replacement for it) etc.

Sheet 2
The phases of the Moon

OBJECTIVES

- Visualize the different phases of the Moon and learn the related vocabulary
- Discover the Sun-Earth-Moon system
- Discover the Moon's rotational movement
- Understand why one side of the Moon is always hidden from us

EQUIPMENT

- A polystyrene ball with a diameter of 8cm (enabling a Moon of this scale to be compared with a 30-cm diameter globe representing the Earth)
- A strong light source (powerful torch or projection device)
- A dark room

INTRODUCTION

As the days go by, different parts of the Moon become visible to us: they wax and wane in the sky. These different shapes vary according to the way in which the Moon is lit, which in turn depends on its position relative to the observer on Earth and in relation to the Sun. Based on a role-playing game, ask the students to take on the roles of the Earth and the Moon in order to visualize the respective positions of the two bodies in relation to the Sun and in relation to each other.
Aside from the role-playing game, you can also simply use objects to model the bodies (polystyrene balls, globes).

PROCEDURE

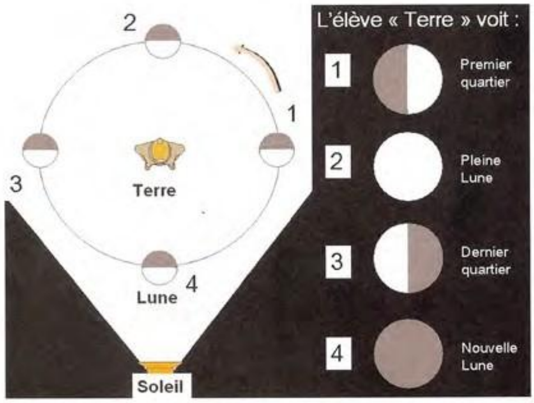
ACTIVITY 1

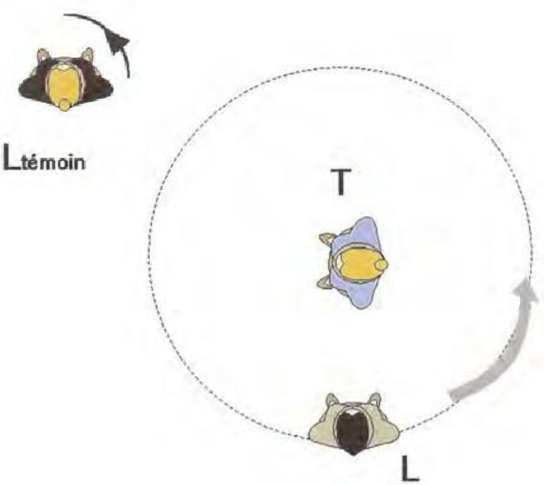
Visualizing and identifying the phases of the Moon

› A source of light is used to represent the Sun.
› A student's head is used to represent the earth.
› The Moon is represented by a polystyrene ball held by another student (stick a pencil in the ball to make it easier to handle and so that it is clearly visible to everyone).

- Ensure the room is placed in darkness.
- The "Earth" student places himself/herself in front of the "Sun" light source.
- The student holding the "Moon" ball turns around the "Earth" student to represent the Moon's revolution around the Earth, which lasts just under a month, i.e. 29.5 days.

- At each change of position, the "Earth" student describes the part of the "Moon" ball that he/she sees illuminated by the Sun. He/she can draw these different phases on the board. Everyone can therefore visualise the different phases, which are then named by the teacher. Different students can play the role of the Earth (one by one or by group).
- The teacher can hold the "Moon" ball instead of the student and, in this case, gradually turn it around its own axis as he/she turns around the "Earth" student. The teacher can then also point out that one side of the Moon (which can be coloured to make it easier to see) is never visible from Earth. He/she can then show real images of the Moon's different phases to highlight that the same craters remain visible, whatever the phase □





ACTIVITY 2

The dark side of the Moon

› A student acts as the Moon.
› Another student plays the role of the Mirror-Moon.
› A third student represents the Earth.

- The "Moon" student turns around the "Earth" student, while always showing him/her his face (the same side). At the same time, the "Mirror-Moon" student reproduces the movement of the "Moon" student, turning so as to follow the position of the "Moon" student (eyes and shoulders facing the same way).
- At the end of a lunar revolution around the Earth, we can see that the Mirror-Moon has turned a full-circle; this is because the Moon rotates around its own axis at the same time as it revolves around the Earth, meaning that we can see only one side of the Moon from the Earth. ■

TO TAKE THINGS FURTHER

Understanding phenomenon of eclipses:

Position the "Earth" student between the beam of light from the Sun and the blackboard/whiteboard. The shadow of his/her head, projected onto the board, represents the Earth's shadow. The student takes the "Moon" ball in his/her hand and then has to create a Lunar eclipse by placing the Moon between his/her face and the board.
In this way, the students can see the relative positions of the three bodies, the position of the Moon at that moment (full Moon) and the part of the Earth that can see the eclipse.

- **Why don't lunar eclipses happen every month?** Due to the Moon's inclination of 5° in relation to the ecliptic plane, the Moon generally passes above or below the Earth's shadow. The 3 celestial bodies are aligned twice a year (every 6 months).
- **How long does an eclipse last?** Seen from Earth, it lasts around 2 hours, i.e. the time it takes for the Moon to pass through the Earth's shadow.

Resources:
http://www.cndp.fr/crdp-toulouse/spip.php?article21307
https://education.francetv.fr/matiere/sciences-de-la-vie-et-de-la-terre/cinquieme/jeu/les-eclipses-solaires-et-lunaires
http://nuit.mnhn.fr/fr/ressources/lune/

Sheet 3
Fake NEWS and disinformation

OBJECTIVES

- Formulate questions based on scientific evidence
- Identify and search for reliable sources of information
- Break down the meaning and ideas of a speech
- Understand the difference between reality and perception

INTRODUCTION

Disinformation consists of distorting or denying facts in order to present a theory that is contrary to the officially or scientifically accepted opinion. Space exploration is a field in which a great deal of wild theories or unfounded information circulates. To identify false information, you need to learn to distinguish between questions based on science and arguments presented in bad faith; you need to be able to question your own perceptions, biases and certainties, and be prepared to doubt.

PROCEDURE

ACTIVITY 1

› Using the picture of an astronaut saluting the American flag (see above, Apollo 15 mission), remind the students that some people claim that man has never been to the Moon. According to these people, the Apollo missions did not take place, and the pictures broadcast were filmed in a studio on Earth.
Ask the students to look at the picture and imagine what the arguments of these sceptics might be. For each of the assertions intended to demonstrate the picture is artificial, ask the students to suggest an experiment or a reliable source of information so as to construct a structured and logical argument that responds to the hypothesis formulated.

› Below are some examples of the arguments put forward to deny the reality of the Apollo pictures, followed by some information that can be used in response.

1/ Why does the flag float when there is no air on the Moon?
A horizontal bar holds it open. It is made from a fabric with metal wires running through it, which gives the flag its pleated appearance.

The astronauts made it move by planting it in the ground, the movement lasted a few seconds in the vacuum due to inertia, then it stopped.

2/ The astronauts' footprints are too distinct, as if made in wet sand. But there is no water on the Moon!
The surface of the Moon is covered in regolith, a compact powder in which the particles remain interlocked, thus retaining the shape of astronauts' shoe-soles. Because there is no air, and therefore no wind, these traces remain intact.

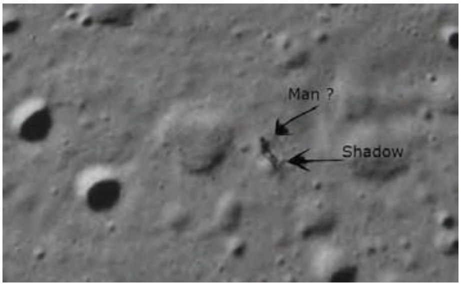
3/ The shadows are not parallel, as if there were several light sources, as if there were spotlights placed all around the scene!
The extremely uneven terrain deflects the light in different places. The wide-angle lens used distorts the perspectives and accentuates the twisted effect of the shadows.

4/ There are no stars!
The cameras used by astronauts are set to capture the light from the Moon, which is lit very brightly by the Sun. To prevent images from being overexposed, the shutter speed is fast so as not to let in too much light. As a result, the starlight is not captured and does not appear in the photo ▪

ACTIVITY 2

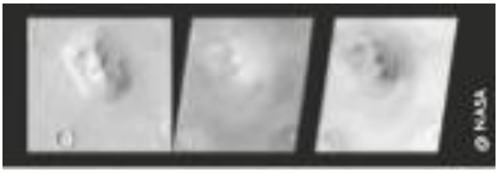
An Internet user has posted a film on YouTube showing the silhouette of a man on the Moon, an image picked up by Google Moon, a service that allows you to visualise the surface of the Moon using NASA images.

› Watch the video *https://www.youtube.com/watch?v=7QdYvelStn8* and/or show students the picture taken from this video.



› Compare it with the picture of Cydonia Mensae, a face shape detected on Mars, which was at the origin of a famous pareidolia, in order to explain this phenomenon, which involves identifying familiar shapes in a landscape, a cloud, an ink blot, an object, etc. Our brains constantly interpret visual information to give it meaning and, to go faster, it draws on known, "pre-recorded" information.

The 1st picture in the series below, taken in 1976 by the American orbiter Viking 1, was reminiscent of a face. Some people think it is a construction sculpted by a form of intelligence. Other probes subsequently photographed the "face", which turned out to be a hill.



› Ask the students to write an article for a scientific journal.
Guideline: explain the phenomenon and give possible scientific explanations.
To do this, the students will draw on the previous information provided and their knowledge of how light is propagated and how shadows are formed, as well as their knowledge of the geological and biological components of a landscape ▪

TO TAKE THINGS FURTHER

- Carry out further research into cases of **pareidolia** and **optical illusions** (http://www.illusions-optique.fr/).
- Ask students to **come up with an experiment** that reproduces this phenomenon, drawing on their knowledge of how light is propagated and how shadows are formed.
- For younger children, suggest using **Google Moon to find other cases of pareidolia** and describe them.

Resources:
https://jeunes.cnes.fr/fr/spatiotheque/12-18-ans/diaporamas/t-reellement-marche-sur-la-lune
https://ires.univ-tlse3.fr/esprit-critique-science-et-medias/?page_id=274 *(IRES activity sheet on pareidolia)*
http://www.film-documentaire.fr/4DACTION/w_fiche_film/11427_1 *[Fake documentary "Opération Lune" (Operation Moon)]*
https://cnes.fr/fr/media/gpvignette-cheval1jpg • https://cnes.fr/fr/media/isalbertavisage20151023jpg *(Terrestrial pareidolia)*

Sheet 4
Launchers

OBJECTIVES

- Understand the principle of jet propulsion
- Understand the idea of air pressure and atmospheric pressure
- Address the concepts of aerodynamics, the relationship between thrust, weight and air resistance
- Work on drawing, cutting and assembly techniques
- Know how to apply safety rules

EQUIPMENT

- Rigid plastic water bottles, such as PET bottles for fizzy drinks (2 per rocket)
- Cardboard (for the fins)
- Adhesive tape
- A cork or a rubber stopper with a pre-perforated hole
- A bicycle valve
- A bicycle pump
- A metal rod
- A little modelling clay

Or, to ensure safety, buy a kit from a recognised supplier.

INTRODUCTION

The water rocket lifts off due to water being ejected under the pressure of compressed air. It is the same principle of jet propulsion that lifts an Ariane launcher! Except that a launcher has to break away from the Earth's gravity and therefore develop thrust and a speed 100 times greater than that of a high-speed train!
Nonetheless, a water rocket can reach heights of up to 20 metres, which means it can be launched from a sports field or in a courtyard and used to make some measurements on site. Particular attention must be paid to safety for this activity.

PROCEDURE

PHASE 1

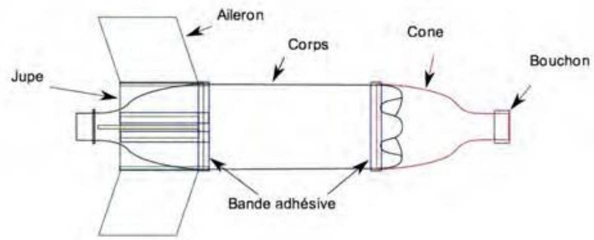
Preparing the rocket

The rocket is made of 3 parts: the skirt (lower part to which the fins are glued), the body (central part subject to pressure), the ogive or cone (the aerodynamic head, cut from the top of a bottle and/or made from a cardboard cone).

› Take 2 bottles and cut one of them into 3 thirds.
Glue the fins, cut from strong cardboard, onto the middle section. Slip this skirt over the top of the other, intact bottle,

leaving the neck sticking out (this will serve as the nozzle for the launch). Consolidate the whole assembly with adhesive tape.

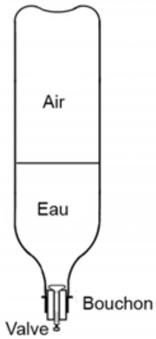
- The top part of the cut-out bottle forms the ogive: slide it over the bottom part of the intact bottle and fix it in place with adhesive tape. You can ballast this part by sticking a little modelling clay under the stopper.
You can also add a parachute, attached by a string to the cone or to the inside of the cone.

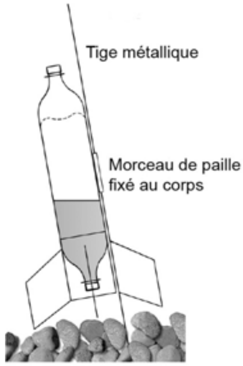


PHASE 2

Preparing the inflation nozzle and launch ramp

- Place the rubber stopper with a pre-perforated hole in the neck of the intact bottle or cut out a cork (with a hole drilled through its entire length) so that it fits perfectly into the bottle neck and seals it, and then insert a bicycle valve.
- Plant a metal rod into the ground, onto which the bottle will be attached using a straw stuck to the bottle with adhesive tape.





PHASE 3

Launch

- Make sure that the "launch ramp" is set up in an open area, away from any roads or houses, ideally in the middle of a sports stadium, and that the students are at least 5 metres behind the rocket. The rocket can rise into the air very suddenly, and go quite high (20-30 metres), and fall back to the ground just as violently (at a speed close to 100km/h). The rocket will not necessarily follow a vertical trajectory.
- Make sure the bottle is robust and in a good state to avoid any risk of explosion. (You can also prevent the risk of water spraying out by controlling the water outlet pressure by pushing the stopper in more or less deeply. In all cases, carry out tests beforehand).
- Fill the body of the rocket with one third of water (if there is too much water, the air pressure will decrease and the thrust on the water will be insufficient to eject it completely from the bottle. If there is too much air, the thrust will be powerful and the rocket will rise into the air, but only for a short moment because the volume of the water providing the thrust will be low).
- Position the bottle on the rod and connect the inflation valve to the nozzle on the pump.
- Operate the pump until the pressure pushes out the cork and the mass of water contained in the bottle. The bottle will take off!

TO TAKE THINGS FURTHER (year 10 and above)

- **Calculating the flight height using a target point (Thales's Intercept Theorem).**
This requires a sighting instrument, a theodolite, which measures an angle in the vertical plane, in this case the angle between the horizontal and the maximum height of the rocket (apogee).
[The theodolite can be made using a straight stick, a protractor and a plumb line.]
Measure the distance between the observer and the launcher and then calculate the height (h) using the following formula: h = distance x tan (angle).
The smaller the angle, the better the accuracy, so it is best that the observer stands about 100 metres from the launcher.
- **To build a mini rocket or an experimental rocket with CNES, please contact:**
education.jeunesse@cnes.fr

Resources:
https://jeunes.cnes.fr/fr/web/CNES-Jeunes-fr/8112-la-fusee-a-eau.php *(Discovering water rockets)*
http://www.planete-sciences.org/espace/Activites/Fusee-a-eau/ *(Manufacturing and applications)*
http://www.planete-sciences.org/espace/Activites/Fusee-a-eau/Fusee-a-eau-en-toute-securite

Sheet 5
Humans in microgravity

OBJECTIVES
- Appreciate the impact of microgravity on the human body (distribution of fluids in the body, impact on the skeleton, etc.)
- Learn about human physiology

EQUIPMENT
- A bench
- Some books
- Two sponges

INTRODUCTION
All objects with mass in the Universe attract each other. This gravitational force depends on the masses of the bodies and the distance that separates them.
On Earth, this force of attraction, known as gravity, or gravitation, enables us to stand upright. It also affects the entire human organism, which is adapted to living as bipeds, under the influence of gravity.
In space, the Earth's gravitational pull decreases as we move away from the Earth. In the International Space Station (ISS), which is 400km from Earth, the Earth's gravitational pull is 10% less. Once the engines have been shut down on board a rocket, or when staying on the ISS (which also orbits the Earth), astronauts live in microgravity.

PROCEDURE

ACTIVITY 1

Observing changes in the distribution of bodily fluids

On Earth, our bodily fluids are drawn towards our feet. In microgravity, the distribution of fluids changes.
For example, the amount of blood in the upper body increases, notably because the heart is used to "pumping" blood upwards to counteract the Earth's gravity.

To prepare the astronauts and measure the effects of microgravity, we use a "tilt bed": a bed with a 6-degree inclination. This device recreates conditions close to microgravity.

› Propose this training exercise to (healthy) students:

- Incline a bench at 6° to the horizontal and ask a student to lie on it, with his/her head pointing downwards (their head should be between 15 and 20cm lower than their feet).
- After 8 to 10 minutes, ask the other students to observe the changes that have taken place:
  - the face swells and becomes red because of the influx of blood, the veins in the arms are dilated (you can measure the diameter of the neck and take a before-and-after photo),
  - the heart rate falls (measure the before/after heart rate using a stopwatch, heart-rate monitor or smartphone app),
  - the volume of the legs decreases due to water loss. In addition, after a prolonged stay in microgravity, astronauts' muscles melt away because they are no longer used (measure the circumference of the calves before and after using a flexible tape measure) ▪

ACTIVITY 2

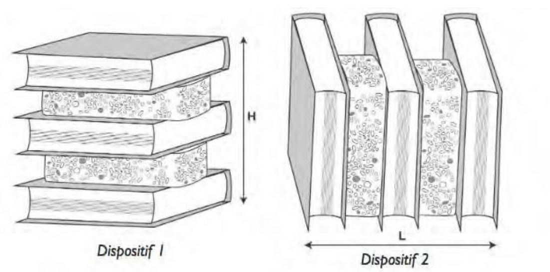
Modelling the spine in microgravity

When astronauts spend a long time in space, they grow! They can gain up to 7cm in 6 months.

› Ask students to suggest hypotheses for this phenomenon.

- Remind students about the structure of the skeleton (depending on the students' level, you can discuss the human growth process, which stops after about twenty years: so, astronauts are too old to grow!)
  Remind students about the effect of gravity, which also has an effect on our skeleton: this gravitational force is exerted along the axis of the spine, as if a weight were pressing on our spine and compacting it.
  In microgravity, this pressure decreases, so the spine stretches.

› Make a model of the spine using books and sponges:
The books represent the vertebrae, the sponges the inter-vertebral discs.



Stacked vertically *(example 1),* the books weigh down on the sponges and compact them.

Laid out horizontally *(example 2)*, the pressure of the books disappears and the sponges expand.

Example 1 represents the spine when subjected to gravity; example 2 represents the spine in microgravity ▪

TO TAKE THINGS FURTHER

- To **observe how the vertebrae** stretch when freed from gravity, you can ask students to measure themselves individually at night when they go to bed and then in the morning when they wake up, over a period of 4 or 5 days, to note and compare the differences.
- Supplement this with **research into muscle loss** in astronauts, whose muscle mass would decrease by an average of 10% during a 6-month stay if they did not do 2 hours of sport a day, and by as much as 30% or 50% as regards the back and leg muscles.
- **Why these muscles?** Do work in science classes on postural muscles, and in PE on specific exercises for these areas.
- Every year, CNES invites high school students and university students to come and **test one of their microgravity experiments:** this is called the **Parabole project**.
  Contact: *education.jeunesse@cnes.fr*

Resources:
https://corporate.cnes.fr/enmicropesanteur *[CNES web documentary]*
https://www.esa.int/Education/ISS_Education_Kit_-_Lower_Secondary *[ESA Education Kit - Middle School]*
https://www.esa.int/Education/ISS_Education_Kit_-_Primary *[ESA Education Kit - Primary School]*

Sheet 6

Man on the Moon


"All the News That's Fit to Print"

The New York Times

LATE CITY EDITION

MEN WALK ON MOON

ASTRONAUTS LAND ON PLAIN; COLLECT ROCKS, PLANT FLAG

Voice From Moon: 'Eagle Has Landed'

A Powdery Surface Is Closely Explored

OBJECTIVES

- Oral comprehension and expression
- Analyzing and communicating
- Learn technical terms (journalistic and scientific)

INTRODUCTION

When Neil Armstrong and Buzz Aldrin landed on the Moon on 21 July 1969, the event was recorded, filmed and broadcast live on television and radio around the world.

The written, video and sound archives are available on the NASA and press websites and provide a basis for lively discussion and debate.

Reading the newspapers from the time will help students understand the subject of space and the related vocabulary, while also providing an opportunity to appreciate the historical context of the period.

The material used here is an article from the New York Times, available at: *https://archive.nytimes.com/www.nytimes.com/learning/general/onthisday/990720onthisday_big.html*

PROCEDURE

ACTIVITY 1

Oral expression

› Start by looking at the front page of the newspaper (above), then ask the students to describe it (depending on the students' levels, the questions can be asked in French or English, and the number of questions adapted accordingly).

- What does the picture represent?
- Who is the person on the picture? How is he dressed? (astronaut wearing a spacesuit)
- Where is he? How do you know that? (image + text: *"astronaut", "moon"...)*
- What are the astronauts doing on the Moon? (see Headline: "*collect rocks, plant flag")*
- Do you know about this event? When did it take place? Who were the astronauts?

- Which tasks did the 2 astronauts perform during their moonwalk? (filming, deploying scientific experiments, collecting samples, etc.).
- Was the landing easy? *("steered their […] lunar module safely and smoothly", "brought their ship to rest", etc.).*

› Select some words expressing that this is an extraordinary event.
("the historic landing / the first human footprint on the lunar crust / excited audience of hundreds of millions of people on Earth / the most daring and far-reaching expedition thus far undertaken").

› Explain Armstrong sentence "That's one small step for man, one giant leap for mankind".

- Why is this an historical moment?

ACTIVITY 2

Link the words to their translation, then find these elements on the front page of the newspaper

Subtitle	Gros titre
Caption	Sous-titre
Headline	Citation
Quote	Accroche
Teaser	Légende

(subtitle: sous-titre, caption: légende, headline: gros titre, quote: citation, teaser: accroche)

ACTIVITY 3

Reading a text and identifying key information

› Ask the students to read the newspaper article and summarize the main points (orally or in writing, ask questions about the first 2 sections of the article - up to the heading *"Nixon Telephones Congratulations"*).

- What happened on July 21, 1969?
- Who was the first man to step on the Moon?
- How did he reach the Moon's surface? Did he jump out of the lunar module? (see *"ladder"*).
- What is the Moon's surface made of?
- Is it difficult to move on the Moon? ("his *ability to move about easily in his bulky white spacesuit", "lunar gravity, which is one-sixth that of the Earth", "hopping and loping about")*

ACTIVITY 4

Identify proper nouns and link them to the corresponding items

Houston	The name of the journalist
Apollo 11	The landing site
Eagle	The name of the mission
Tranquillity base	The name of the lunar module
John Noble Wilford	The city in which the control centre is located

(Houston: the city in which the control centre is located, Apollo 11: the name of the mission, Eagle: the name of the lunar module, Tranquillity base: the landing site, John Noble Wilford: the name of the journalist)

TO TAKE THINGS FURTHER

- Based on the article, **write a short dialogue** between Buzz Aldrin and Neil Armstrong talking about their first impressions (feelings, description of the lunar landscape that they discovered, etc.).
- **Identify the verbs** in the preterit (past simple) tense and classify them into two categories: regular and irregular verbs.
- **Identify occurrences of the present perfect:** simple identification of the verbs for level-1 students; explanation of why the present perfect was used as opposed to the preterit (past simple) tense for level-2 students.

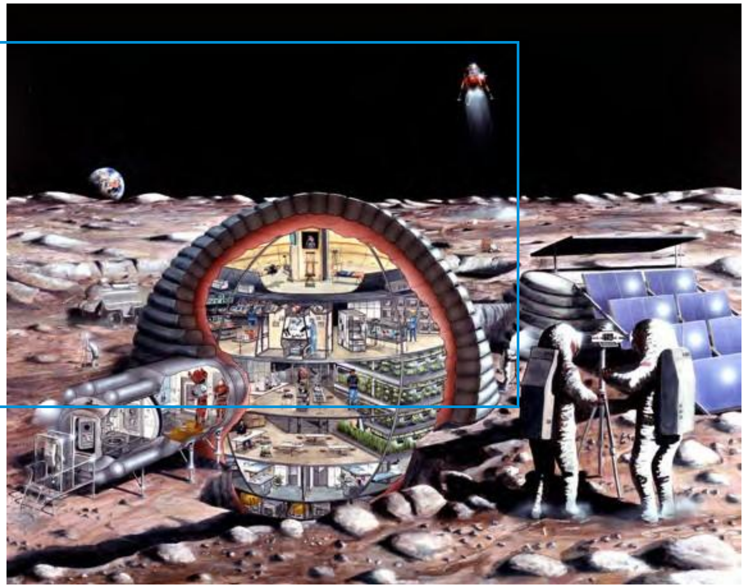
(preterit (past simple) = action that occurred at a past time / present perfect = result of a past action in the present (the time referred to is not just "Past" time), strong link with the present which reinforces the idea of a great step forward for mankind - see Discussion with President Nixon).

- **Continue reading** the text through to "the two moon explorers settled down to sleep": **discuss the historical context** , drawing on the telephone conversation with President Nixon (space exploration and the Cold War).

Resources: https://www.nasa.gov/mission_pages/apollo/index.html *[Apollo website of NASA]*
https://www.esa.int/esaKIDSen/SEMXR6WJD1E_OurUniverse_0.html *[ESA Moon page for kids]*
https://www.hq.nasa.gov/alsj/a11/a11.step.html *[written and audio transcription of the dialogue between Apollo 11 and Houston]*

Sheet 7

Living on the moon



OBJECTIVES

- Discover and understand the lunar environment
- Analyse and compare scientific data
- Imagine and describe living on the moon

INTRODUCTION

A lunar day lasts around 14 Earth days, with temperatures that can reach +120°C. At night, the temperature drops to an average of -150°C, lasting the equivalent of 14 Earth days (see: rotation of the Moon). The temperature can drop as low as -230°C in the coldest places, at the bottom of craters at the poles. The South pole also contains reserves of water in the form of ice.

Finally, the Moon exists in a vacuum due to the virtual absence of gravity, which prevents particles from remaining on its surface and therefore the formation of an atmosphere, which can protect against radiation or falling meteorites. In short, an environment that is not very suitable for life! And yet, Humankind is planning to settle there.

PROCEDURE

ACTIVITY 1

Carrying out research and creating a comparative chart of the Earth and Moon

Using the model suggested below as a guide, ask the students to draw up a table that compares the characteristics of the Earth and the Moon and the consequences/effects of those characteristics for humans.

	On Earth	On the Moon	Explan-ation	Conseq-uences
Temperature				
Atmosphere				
Gravity				
Climate				

Temperature
On Earth: extreme temperatures range from +50°C to -80°C.
On the Moon: extreme temperatures range from +120°C to -230°C.
Explanation: the absence of a protective atmosphere that creates a regulating greenhouse effect.
Consequences: extreme temperatures with too great an amplitude in variations for the human body to bear!

Atmosphere
On Earth: a mixture of gases whose presence and concentration gradually diminish as you rise in altitude.
On the Moon: a vacuum.
Explanation: because the Moon has no atmosphere, it is in the vacuum of space.
Consequences: absence of pressure and oxygen.
Impossible to breathe, the air contained in the body escapes, the pressure inside the body increases because it is not counter-balanced by external pressure.

Gravity
On Earth: if Earth's gravity = 1.
On the Moon: 6 times weaker than on Earth.
Explanation: the mass of the Earth is much greater than that of the Moon. Since the gravitational force is proportionate to mass, the Earth's gravitational attraction on a human being is more powerful.
Consequences: a human being weighs 6 times less on the Moon. 100kg on the Moon is as easy to carry as 16kg on Earth.

Length of the day
On Earth: 24 terrestrial hours, with approximately 12 hours of night and 12 hours of day.
On the Moon: 1 lunar day is equivalent to 29 terrestrial days (29d, 12h, 44min).
Explanation: the Moon takes 29.53 days to return to the same position opposite the Sun. Since it takes roughly the same amount of time to turn on itself, about half of that time is during the day, and the other half at night.
Consequences: the duration of the daylight period is much greater than on Earth (except at the Earth's poles). Conversely, periods without light also last longer.

Water
On Earth: present on Earth in its 3 states (solid, gaseous, liquid), therefore allowing life to exist.
On the Moon: only present in solid form, with reserves of frozen water under the poles.
Explanation: the states of water depend on pressure and temperature. The pressure on the Moon's surface is zero, and there are extreme variations in temperature. These conditions do not allow water to remain present in liquid or gaseous form.
Consequences: no life possible, because no oxygen or liquid water ▪

ACTIVITY 2

Imagining day-to-day activities on the Moon

Based on the differences listed above, imagine what it would be like doing typical day-to-day Earth activities on the Moon. Here are a few ideas:

Sports session
Because the gravitational force is so weak, playing sport would be great fun: a jumper would be able to jump 6 times further and higher than on Earth, and the same thing applies to a ball! This means that we would need football pitches 6 times bigger than those on Earth, for example!

Recreational break
You cannot live outdoors without protective equipment. What would a recreation area look like: a yard with an artificial garden?

Food
Could we create soil and grow food, or would it be necessary to grow crops hydroponically, using water extracted from the lunar subsurface?▪

TO TAKE THINGS FURTHER

Compare the attraction of the 2 bodies:

We use weight to compare lunar and terrestrial gravitation in the simplest way. The weight of an object of mass *m*, located on the surface of a celestial body is expressed by:

$$W_{Body} = m \times g_{Body}$$

With g_{Body} the gravitational intensity in $N.Kg^{-1}$

For example $g_{Moon} = 1.6\ N.Kg^{-1}$ and $g_{Earth} = 9.8\ N.kg^{-1}$
We can therefore calculate the weight of an object with a mass of 80kg, like the mass of a man, on the Moon or on Earth.

Resources:
http://ufe.obspm.fr/IMG/pdf/tp_lune_crash.pdf *[Surviving on the Moon, Paris Observatory activity]*
https://cnes.fr/fr/la-terre *[Identity cards for the earth and the moon]*

EXHIBITION

MOON EPISODE II

Fifty years after the first step on the Moon, on 20 July 1969, plans for a return to the Moon are back in the news. Together, let's take up the challenge of sending a human-being back to the Moon!

With **"MOON - Episode II",** the Cité de l'Espace's temporary exhibition, relive the exploit of the Apollo mission, and prepare for this new challenge by discovering the real nature of the lunar environment and the constraints of future missions, all supported by practical experiments!

From April 2019

at the Cité de l'Espace

www.cite-espace.com

TOULOUSE
itédel'espace
DÉCOUVRIR • S'ÉTONNER • COMPRENDRE

// project parabole:
With CNES, give your high school or university students the opportunity to carry out an in-flight experiment on board the zero-g Airbus A310.

THE SPIRIT OF SPACE

CNES (*Centre National d'Études Spatiales*, the French Space Agency) is involved in both research and industrial operations in the space sector. It establishes France's space policy at national, European or international levels.

With its 4 centres and 2,500 employees, CNES designs, develops and implements space projects and operations: launchers, satellites, space probes and associated ground segments. CNES is involved in five main areas: **Ariane, Science, Observation, Telecommunications and Defence.**

Since its creation in 1961, CNES has pursued an active policy of promoting the culture of space and science to young people and teachers. In addition to designing and distributing informative tools and materials, it provides training for teachers as well as space-related data and files for educational projects to be carried out in the classroom or in clubs. The contents of this booklet of documents and the associated activity sheets can be downloaded from the teacher-mediator area on the CNES website.
Enjoy reading!

cnes.fr
https://jeunes.cnes.fr/

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

Pôle multimédia CNES -2018-448