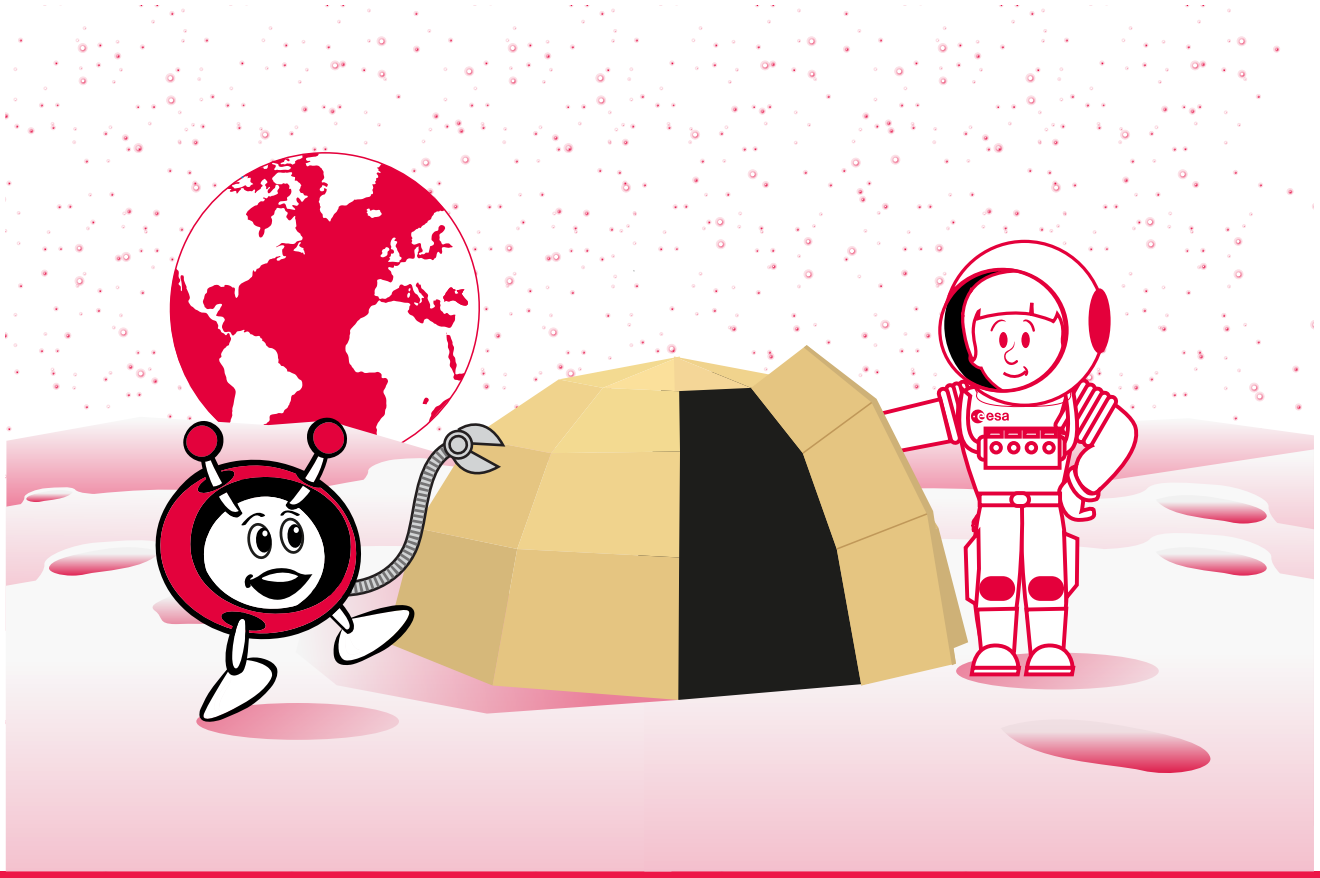
primary | PR37

teach with space

→ MOON SHELTER

Investigating different shelters on Earth and in space



teacher guide & student worksheets

European Space Agency

teach with space – moon shelter| PR37
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→ MOON SHELTER

Investigating different shelters on Earth and in space

Fast facts

Subject: Science, Arts

Age range: 8-12 years old

Type: student activity

Complexity: medium

Lesson time required: 90 minutes overall

Cost per class: low (0-10 euro)

Location: classroom

Includes the use of: craft material (sand, clay, polystyrene, plastic, balloons)

Keywords: Science, Arts, Moon, Shelter, Weather

Brief description

In this set of activities pupils will analyse the importance of having shelter for protection on Earth and in space. Pupils will compare the environmental conditions on Earth and on the Moon and in a group they will imagine and build their own Moon shelter using materials comparable to the soil on the Moon, known as Moon analogues.

Learning objectives

- Recognise the importance of shelters in providing protection from the environment.
- Relate environmental conditions with known shelters.
- Understand that the atmosphere is important for life on Earth.
- Recognise that the Earth and the Moon have very different environmental conditions.
- Identify some necessary features of a shelter on the Moon.
- Improve their ability to work in a group and their creative thinking.

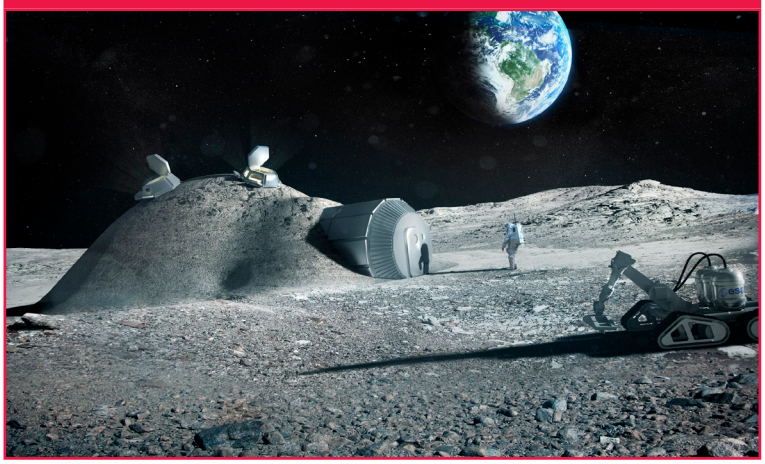
→ Summary of activities

activity	title	description	outcome	requirements	time
1	Taking shelter	Pupils identify local environmental conditions and shelters.	Pupils should identify different properties of common shelters and link them to the environmental conditions.	None	10 minutes
2	World shelters	Pupils identify extreme environmental conditions and the shelters used in those conditions.	Pupils should be able to relate extreme environmental conditions with the need for special shelters.	Completion of activity 1	20 minutes
3	Could you live on the Moon?	Pupils investigate the differences between the Earth and Moon environments.	Pupils should learn that the environment on the Moon is very hazardous. Pupils should also learn about the protective role the atmosphere has on Earth.	Completion of activity 2	10 minutes
4	My Moon shelter	Pupils design and build their own Moon shelter using materials comparable to Moon soil (Moon analogues).	Pupils should learn about some of the constraints of space exploration and some of the special features that shelters should have in space.	Completion of activity 3	50 minutes

→ Introduction

ESA is working on new missions to the Moon in order to study the environment and to develop technologies, which could one day help setting up a lunar base. Perhaps astronauts will be living on the Moon in the next two decades.

Figure 1



↑ Artistic impression of a Lunar base made with 3D printing

Space, outside of our home planet can be an extremely hostile environment for humans to live. Unlike Earth, the Moon has no atmosphere (it is in a vacuum), this means that there is no air to breathe. In addition, this lack of atmosphere leaves no protection from collisions with even the smallest meteoroids (the dust and rock debris present throughout the Solar System) or from harmful radiation from the Sun. One day on the Moon lasts for 27.3 Earth days; of this there are 14 days of day time, followed by 14 days of night time. The temperature variation between day and night time is extreme. The temperature can be as high as +123 °C and as low as -233 °C, depending on the location.

Building infrastructure on the Moon would imply taking many materials from Earth, which would be very expensive to transport. Therefore, engineers are investigating new building techniques, such as 3D printing, using local materials like the lunar soil (regolith).

Through this set of activities students will investigate different shelters on Earth and imagine how a future shelter on the Moon could be.

→ Activity 1: Taking shelter

In this activity, pupils analyse their local environment and identify the weather events that they take shelter from in their daily lives. They will also identify the characteristics of different shelters and their positive and negative points. Pupils should record their answers in the worksheet or in their notebook.

Equipment

- Student worksheet printed for each pupil
- Pen/pencil

Exercise

To introduce the topic ask the pupils if they have ever had to protect themselves from the weather. Discuss with them what type of weather they have experienced and what kind of shelters they have used in those situations.

Explore the pupils' ideas of different types of shelters and the situations where they are most suitable.

The pupils should understand that different shelters have positive and negative characteristics. For example: if it is raining, they could take shelter under a covered bus stop, which is easy to access (positive) but it will not provide complete cover if it is raining heavily (negative).

Discussion

Every day we are exposed to different weather conditions, such as wind, rain, snow, radiation from the Sun, cold and hot temperatures, storms, thunderstorms, tornadoes, etc. We can protect ourselves from their negative effects by taking shelter inside a building or another structure (for example under a tree or a bus stop, inside a tent or a car). We also take shelter from other dangers like wild animals, crowds, loud noises, etc.

→ Activity 2: World shelters

In this activity, pupils will investigate the different environments that exist on Earth. They will compare their local weather conditions to some of the most extreme that occur around the world. They will then explore the types of shelters that are used in these locations.

Equipment

- Student worksheet printed for each pupil
- Pen/pencil

Exercise

Ask pupils what are the worst weather conditions that they have ever experienced.

Ask them to relate their experiences to what they think the conditions are like in the rest of the world. Explore the pupils' ideas of different extreme weather conditions.

Distribute the student worksheets. Ask pupils to look at images 1-4 on their worksheets. Ask them to write down the description of the weather conditions shown in the images.

After pupils have finished the first question, you could have a short discussion with the class about their answers and what the images show, or you could leave it until pupils have also completed the second question.

For question 2, students should relate the weather conditions shown in question 1 to different shelters. Ask pupils to describe the shelters shown in images A to D. Ask them to match each of the weather conditions from question 1 to the most suitable shelter shown in question 2 and explain why that type of shelter might be useful in those conditions.

Discussion

The climate on Earth is not homogeneous. There are regions where climate conditions are so extreme that they can be considered hostile to humans. In these environmental conditions humans have to use special shelters to protect themselves.

Information about the examples given on the student worksheet:

Image 1 shows an Antarctica explorer. This continent has no indigenous inhabitants; the population is mainly composed of research staff (scientists and technicians). The population of this continent can vary between 1000 to 5000. The inland regions of Antarctica have very low precipitation levels (<250mm per year) and are classified as desert. Antarctica is considered the largest desert on Earth. In the inland regions the temperatures are also very low, with an average of -57°C.

Image 2 shows the Sahara Desert, the largest hot desert in the world. It extends over 10 countries, covering over 9 million square kilometres, almost 1/3 of the African continent. This image represents a common sight in this region, with large sand dunes shaped by the wind. Temperatures reach values over 40°C.

Image 3 shows flooding in Sri Lanka during the monsoon season. The monsoons are seasonal winds caused by an imbalance of temperature over ocean and land surfaces, which lead to changes in precipitation. Large monsoons are common in Asia, Africa and Australia.

Image 4 shows two atmospheric phenomena: a thunderstorm and a tornado. A thunderstorm occurs when a difference of temperature causes warm water vapour to condensate, giving origin to cumulonimbus clouds. Thunderstorms can be followed by other hazards, such as tornadoes. A tornado is a rapidly rotating column of air.

Image A – links to Image 2. A Berber tent near Zagora, Morocco. Traditionally the communities that live in the desert are nomadic, moving through large expanses of land to find resources (water and food). The shelters have to be compact and easy to transport, and at the same time protect from the harsh environmental conditions.

Image B – links to Image 4. An underground bunker. This type of structure is usually built from concrete with reinforced walls and doors. This provides the most reliable type of shelter from very extreme events such as tornadoes, hurricanes, radiation, etc.

Image C – links to Image 1. Concordia research station in Antarctica. It is one of the coldest driest and most isolated outposts in the world. In winter it hosts up to 15 crew members during a period of 9 months of complete isolation, including 4 months of complete darkness. The coldest temperature ever recorded at the station was -84.6°C.

Image D – links to Image 3. Typical river houses on the River Kwai in Thailand. In areas that are affected by repeated flooding traditional houses are built on floating structures or stilts.

→ Activity 3: Could you live on the Moon?

After exploring different conditions on Earth in Activities 1 and 2, pupils will now investigate the different conditions that exist in space - focusing on the Moon.

Equipment

- Student worksheet printed for each pupil
- Pen/pencil

Exercise

When introducing or concluding Activities 3 and 4 it may be useful to present more information about Moon exploration. Useful resources and reference information can be found in the Links section.

Distribute the student worksheets. Ask pupils to describe some of the Moon's characteristics that they can observe in the images.

Ask them to identify differences between the Earth and the Moon pictures.

Ask pupils if they think it would be easy for Humans to live on the Moon. What dangers do they think astronauts would face on the Moon?

Discussion

The Moon is a very hostile and dangerous environment for humans. The landscape is completely barren and is covered in very fine dust. Contrary to the Earth, the Moon has no atmosphere to provide protection from meteorites and radiation. There is also no air for the astronauts to breathe and astronauts would be exposed to the vacuum of space.

The usual concept of weather is not applicable to the Moon, because there is no atmosphere. Nonetheless the environmental conditions can change due to interaction with the Sun – this is known as space weather.

On the Moon a night lasts for 14 Earth days. Astronauts on the Moon would have to endure extreme variations of temperature between day and night.

When outside the lunar vehicle/spaceship the astronauts have to use special protective suits to protect themselves from radiation, high and low temperature and from the vacuum.

→ Activity 4: Making a home on the Moon

In this activity pupils will apply the knowledge they have acquired in the previous activities to design and build their ideal Moon shelter.

Equipment

- Student worksheet printed for each pupil
- Pen/pencil
- Clay
- Plastic
- Polystyrene
- Balloons

Exercise

Following Activity 3, ask pupils to think about their ideal Moon Shelter. They should draw a sketch (or write a short text) to describe the shelter on their student worksheet. Their description should include the different factors the shelter offers protection from and identify the main materials needed to construct their shelter.

Next, discuss with pupils some of the constraints that space agencies face when planning their missions. Ask them to adapt their design, as much as possible, to use local (Moon) resources, and light and/or inflatable materials. Distribute to the pupils some materials similar to the ones future Moon astronauts would have ("lunar soil" - clay, plastic, polystyrene, balloons) and ask them to build their own Lunar Shelter.

Discussion

At the design phase, you could provide pupils with more information about the Moon or ask them to do their own research. Some useful links are available in the Links section. You can also let the students design their Moon shelter with no constraints and provide more information afterwards. This could stimulate a debate about their design choices and the functionality of their shelter in the Moon environment.

When designing their Moon shelter, pupils should consider that on the Moon this outpost could be the only structure that exists for the astronauts and therefore, it should be self-sustainable.

The shelter should provide protection from meteorites and radiation to astronauts and equipment (for example computers). It should provide an environment with regulated temperature and a simulated atmosphere where astronauts can breathe without oxygen tanks. It should also contain an area where food can be grown and a water recycling system. It should provide a working and living area for the astronauts.

New technologies are being developed to support the future exploration of the Moon. These include 3D printing using lunar soil analogues, inflatable structures, temperature regulating materials, plants research, remotely operated robots, dust mitigation technologies, new propulsion technologies, exploration of the ice discovered at the lunar poles, water purification devices, extraction of water and metals from the regolith and much more.... More information can be found in the links section.

→ Conclusion

This set of activities provides an introduction to the environmental conditions on the Moon, and relates them to the conditions on Earth. Pupils should become aware of the importance of the Earth's atmosphere and the challenges of space exploration.

→ MOON SHELTER

Investigating different shelters on Earth and in space

→ Activity 1: Taking shelter

1. List 5 weather conditions from which you have taken shelter and 5 different shelters you have used.

weather conditions	shelters
Rain	Bus stop shelter

2. For each shelter you have listed in question 1 identify a positive and negative characteristic

Shelters	Positive characteristics	Negative characteristic
Bus stop shelter	Easy to access	

→ Activity 2: World shelters

1. Describe the weather conditions shown in images 1-4.

↑ Image 1

↑ Image 2

↑ Image 3

↑ Image 4

2. Describe the shelters in images A to D. Can you match the shelter with the weather conditions shown in the last page and explain why that type of shelter might be useful in those conditions?

↑ Image A

↑ Image B

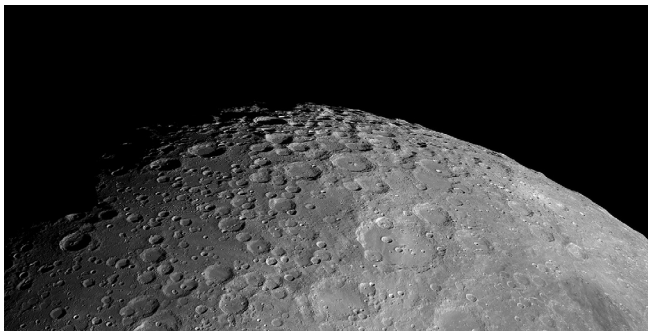
↑ Image C

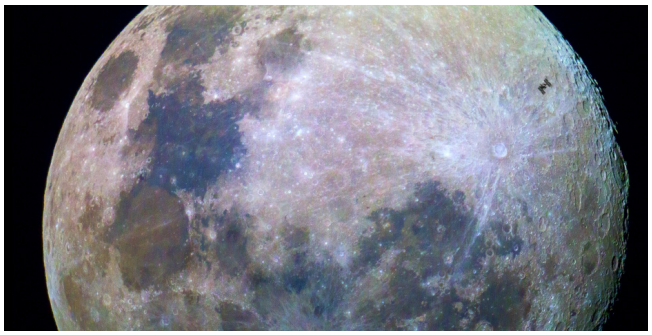
↑ Image D

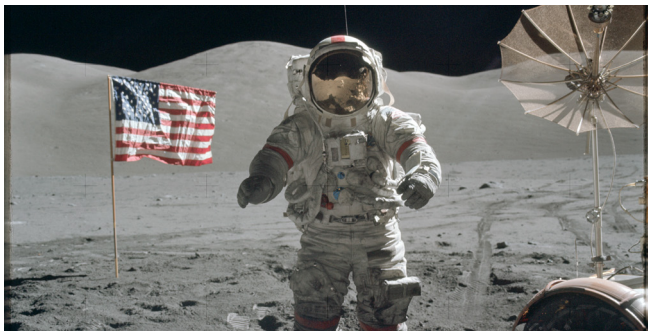
→ Activity 3: Could you live on the Moon?

Do you think the environment on Earth can be extreme? Well, space is much worse!

Study the following pictures. Can you identify differences between the Moon and the Earth? Which hazards would astronauts come up against on the Moon? Write your answers and describe some of the Moon's characteristics in the lines below.







The Moon is...

→ Activity 4: My Moon shelter

How would you design a shelter to protect astronauts from the hazardous Moon environment?

1. Draw your ideal Moon shelter and label the most important features. Describe the protection your shelter provides and list the materials you would need.

materials	it protecs from...

My Moon shelter...

Space exploration is extremely difficult.

- The environment is very harsh.
- The distances are very big, even if the destination is the Moon.
- Travelling to space is very expensive. Depending on the final destination, the cost per kilogram can vary from a few thousands of euros to several hundreds of thousands of euros.

2. Would you like to update your initial design? Would you still use the same materials?

3. Build your own Moon shelter!

→ LINKS

ESA resources

Moon Camp Challenge: esa.int/Education/Moon_Camp

Moon animations about Moon exploration:
esa.int/Education/Moon_Camp/Making_a_Home_on_the_Moon

ESA classroom resources: esa.int/Education/Classroom_resources

ESA Kids: esa.int/esaKIDSen

Paxi animations: esa.int/spaceinvideos/Sets/Paxi_animations

ESA kids article, Moon exploration: esa.int/esaKIDSen/SEMXR6WJD1E_OurUniverse_0.html

ESA kids article, Back to the Moon!: esa.int/esaKIDSen/SEMQBSXJW7J_OurUniverse_0.html

ESA space projects

The Moon, ESA's interactive guide: www.lunarexploration.esa.int

Destination Moon: esa.int/spaceinvideos/Videos/2015/01/Destination_Moon

Moon village: esa.int/spaceinvideos/Videos/2016/03/Moon_Village2

Spaceship EAC heading for the Moon:
esa.int/spaceinvideos/Videos/2016/02/SpaceShip_EAC_heading_for_the_Moon

Concordia research station: www.blogs.esa.int/concordia/research-on-planet-concordia

Space research at Concordia:
www.esamultimedia.esa.int/multimedia/publications/Concordia_Living_on_white_Mars

→ ANNEX

Activity 2: World Shelters

Figure 1

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↑ Medical doctor Beth Healey in Antarctica.

Figure 2

↑ Sand dunes in Morocco.

Figure 3

↑ Monsoon flooding in Sri Lanka.

Figure 4

↑ Tornado and thunderstorm.

Figure A

↑ A Berber tent near Zagora, Morocco.

Figure B

↑ Underground shelter.

Figure C

↑ Concordia station.

Figure D

↑ Typical river house at the River Kwai, Thailand.

Activity 3: Could you live on the Moon?

↑ Full Moon seen from the International Space Station in 2014 by ESA astronaut Alexander Gerst.

↑ International Space Station passes Moon.

↑ The Moon.

↑ Apollo 17 astronaut Eugene Cernan on the Moon.