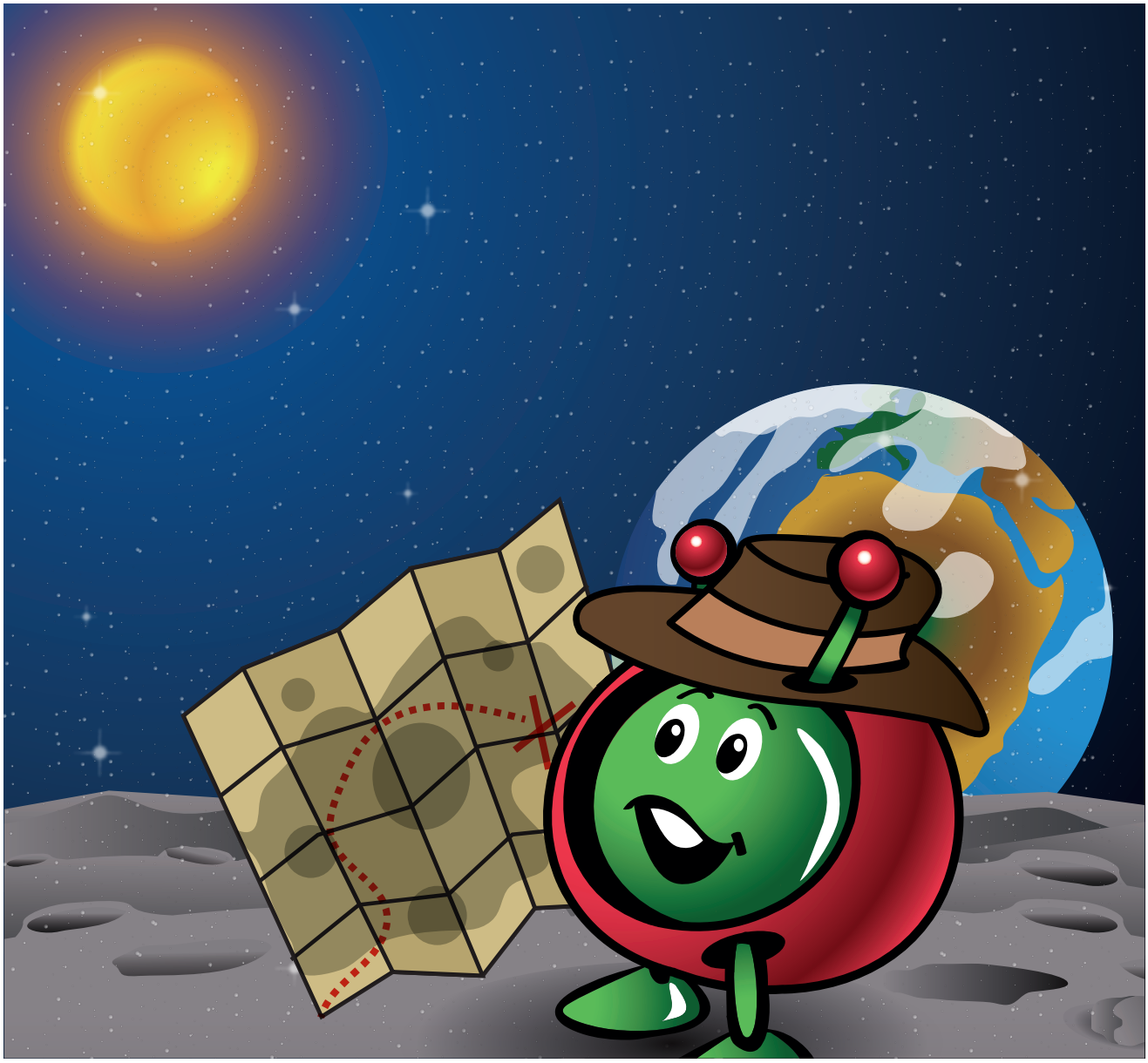
teach with space

→ MISSION ON THE MOON

Program a classmate to complete a mission on the Moon



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→ MISSION ON THE MOON

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Fast facts

Subjects: Computing, Mathematics, Arts

Age range: 8 – 12 years old

Type: student activity

Complexity: easy

Lesson time required: 45 minutes

Cost: low

Location: classroom

Keywords: Computing, Mathematics, Arts, Programming, Communication, Mission Control, Role-play

Brief description

This activity will introduce students to logical thinking by planning, testing and executing a simple mission on the Moon. Students will work in pairs and take it in turns to play the roles of "mission controller" and "rover". One student will give commands to enable the other to navigate blindly across the lunar surface. They will have to follow a set route to avoid obstacles, carry out missions and arrive safely at their final destination.

Learning objectives

- Understanding simple concepts of logical thinking.
- Planning and testing simple tasks.
- Understanding basic step by step programming.
- Learning to communicate through role-play.
- Reading grid references and providing clear and concise instructions to help navigate in the reference space.
- Recognising the importance of clear communication.
- Understanding the importance of teamwork.

→ Summary of activities

activity	title	description	outcome	requirements	time
1	Mission Planning	Planning a sequence of movements for a rover to follow in order to complete defined objectives.	Understanding the importance of step by step instructions. Introduction to planning and testing programs.	None	15 minutes
2	Design and test your mission	Working in pairs playing the roles of “mission controller” and “rover” to achieve the defined objectives and arrive safely at a final destination.	Using logical thinking and simple commands (programing language) to operate a rover. Understanding the importance of clear and concise commands.	Completion of Activity 1	30 minutes

→ Introduction

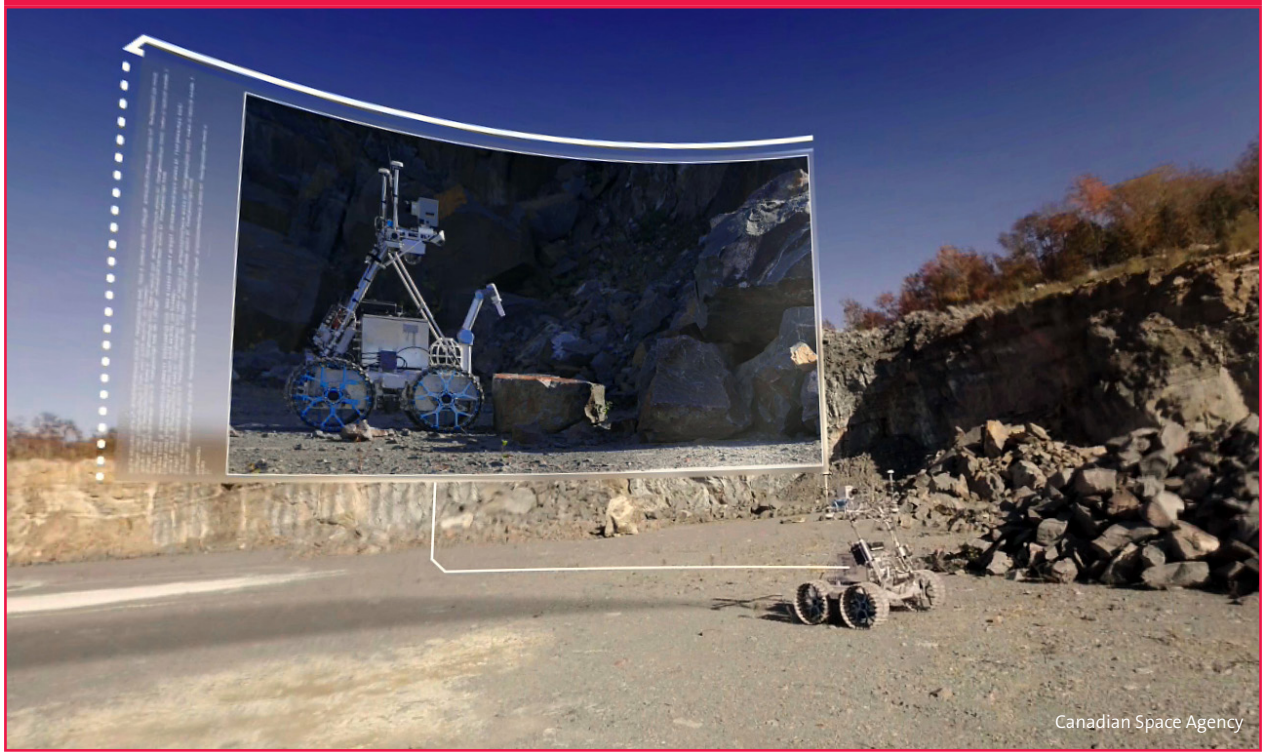
Space agencies around the world see returning to the Moon as the next major step in space exploration. Only 12 astronauts have ever set foot on the Moon. Since the 1970s, lunar exploration has continued with remote sensing techniques and robotic missions, but there is still a lot more left to explore.

Human and robotic space exploration responds to the deeply rooted quest of humankind for answering questions about the origins and nature of life in our Universe and extending human frontiers.

In the next decades several new robotic and human missions are planned to go to the Moon. They will carry out scientific experiments and bring back tons of diverse geological samples. The Moon is scientifically diverse with many places to explore. Interesting locations include the still mysterious far side, the lunar poles (both north and south), volcanic deposits, impact craters and basins, and lava tubes or pits. Rovers will allow remote exploration, mapping and sampling of these areas.

The first mission planned to land on the Moon and return sample to Earth is Heracles, a joint mission between ESA and the Canadian and Japanese space agencies. Heracles will study the potential of human–robot partnerships. Astronauts will tele-operate the rover from lunar orbit to help select better samples to return to Earth. The samples will afterwards be collected on the lunar gateway, by the astronauts, and returned to Earth.

Figure 1

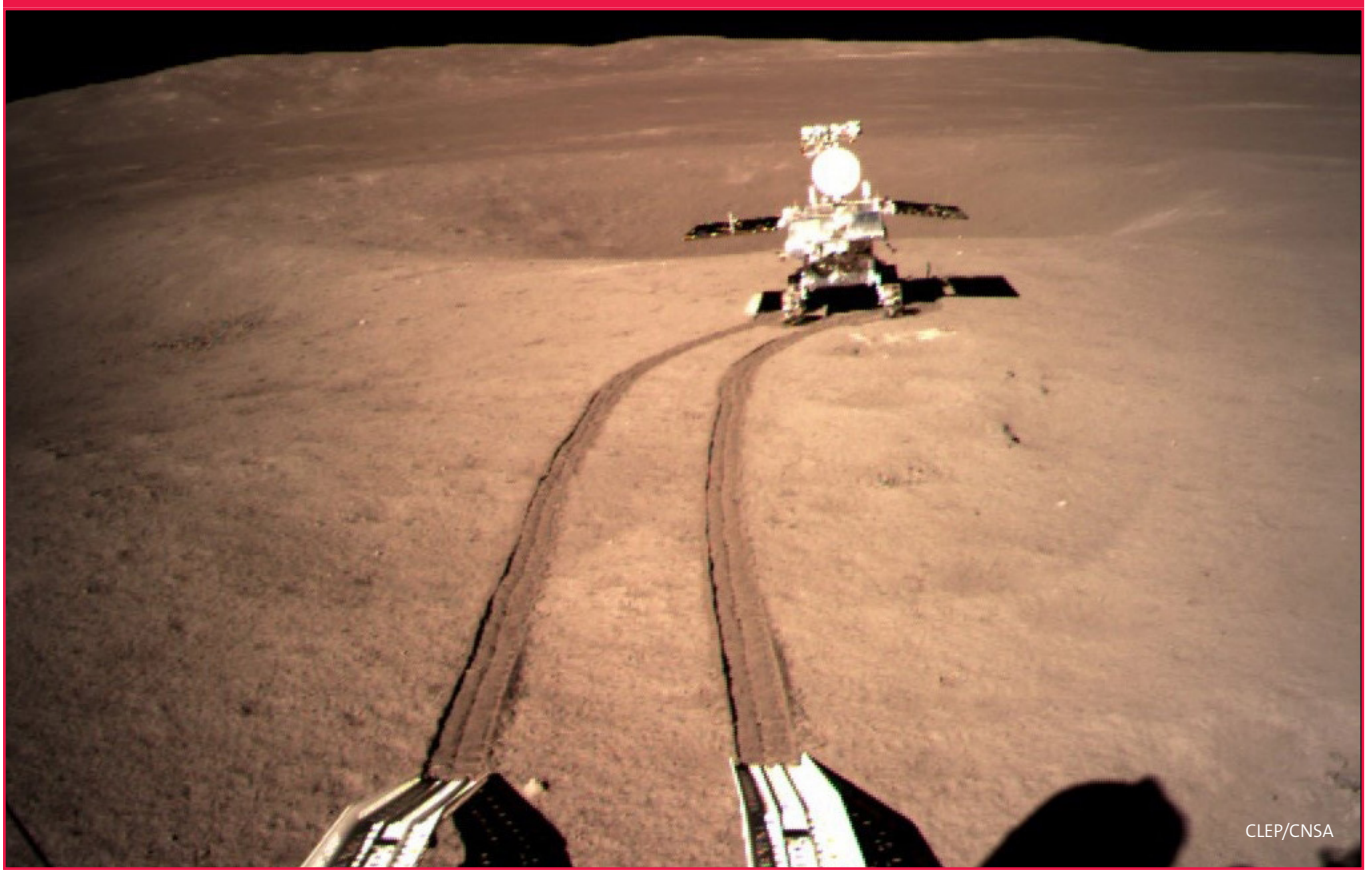


↑ A prototype of the Heracles rover being tested in Canada, in a Moon-like landscape.

Controlling space rovers in real time from Earth's surface is not possible because it takes time for the communication signals to travel from Earth to other celestial bodies. While for the Moon it is just seconds, for Mars it will vary between a few minutes and over half an hour. Rovers need to be programmed to navigate unfamiliar terrain without real time input from humans. Space rovers also use different sensors to scan and map the terrain around them to be able to navigate autonomously. Human-controlled rovers will prepare future astronauts for driving vehicles on the rugged surface of the Moon.

Every current communication method used requires that the transmitter and receiver have a direct link. On Earth, we can communicate easily around the globe because several communication satellites can receive signals from different satellites and transmit them to receivers located in different points on the planet. With big ground station antennas on Earth this is also possible for rovers and astronauts on the near side of the Moon.

Figure 2



↑ The Chinese mission Chang'e-4 was the first mission to land on the far side of the Moon, on the 3rd of January 2019.

For a mission on the far side of the Moon to communicate with Earth, a communication satellite will have to orbit the Moon and relay communications with Earth and the rover.

This resource will introduce students to the basics of planning a mission on the lunar surface. They should apply logical thinking to complete their mission successfully and understand the importance of effective communication.

→ Activity 1: Mission planning

In this activity students will complete a mission on the Moon by guiding an imaginary rover on the Moon. Students will have to list a series of instructions to reach from the landing site to a final destination while carrying out a mission and avoiding hazards on the way.

This activity is an introduction to logical thinking. Older students can skip this activity and go directly to Activity 2.

Equipment for each pair

- Printed student worksheet

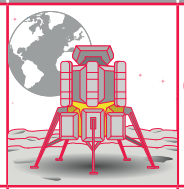
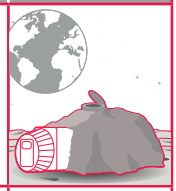
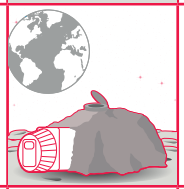
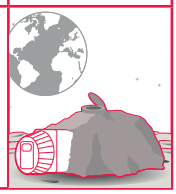
Exercise

Arrange the students into pairs and distribute a student worksheet to each pair.
To accomplish their mission successfully students will have to identify the key elements of the mission and identify the best path for the rover to take.

The students must list the series of movements the rover should make on the mission planning template on the student worksheet. They may only use the forward, turn right, turn left and turn around commands.

Highlight to the students that when we write a computer program we have to plan what we want it to do first and then test it. This is a vital step in mission planning. If we do not do this, we have no way of knowing if our mission will be successful.

Results

MISSION	START	NUMBER OF MOVEMENTS										END
		1	2	3	4	5	6	7	8	9	10	
Mission 1: Landing site to the Moon base												
Mission 2: Moon base to collect ice sample												
Mission 3: Return to Moon base												

→ Activity 2: Design and test your mission

In this activity students will work in pairs to design their own missions on the Moon. They will play the role of mission controller and create a mission for their classmate, playing the role of a rover, to carry out. They will take turns playing the two different roles.

Equipment for each pair

- Printed student worksheet
- Tape

Exercise

Arrange the students into pairs and distribute the student worksheets. They will each take a turn at playing the roles of "mission controller" and "rover".

Exercise 1 – design your mission

First, both students individually should take the role of "mission controller" and use the lunar surface grid map to plan the mission for the other student to carry out. Similarly to Activity 1, they should arrange, as they see fit, the objective/hazard cards on the grid. Afterwards they should list the needed commands on the mission planning table to guide the rover along a path, completing the mission objectives as they go along and avoiding hazards. These objectives can include taking regolith samples, refuelling, collecting ice and returning to the base. The other student should not have access to this information at this point. Each student should only see the map they have created.

If you prefer you can also pre arrange the missions before handing them out.

Exercise 2 – test your mission

Now both students will role play their missions. Set out a 5 x 5 grid on the floor using tape (or similar) to represent the lunar surface grid map.

Each student will act as the "mission controller" to the mission they have defined in step 1 and as the "rover" to their colleague's mission. The students should decide who will start as "mission controller", the student that will start as "rover" should be blindfolded and start at the landing site (guided there to begin with). The student who has the role of rover will have to follow the directions from the mission controller inside the grid on the floor. The "mission controller" should use the commands written on their mission planning sheet. Encourage the students to use grid references when commanding the rover.

Obstacles (such as chairs) can then be placed in the squares corresponding to the hazards on the grid the mission controller has. Objects corresponding to the objectives can be placed in the matching squares for the rover to collect as it goes.

The students should swap roles and the new mission controller will guide the new rover. This grid can also be adapted with different pictures and terrains.

Discussion

The students should discuss what went well in the activity and what could be improved. Was there a problem with the communication? Were the instructions provided clear enough? How could it be improved in the future?

The students should realise how important it is to be clear and concise with their list of commands. They should notice that there is a big difference between, for example, saying “turn and move forward” and “turn 90 degrees to your left and move two steps forward”. If some information is not clear it could lead to the failure of the mission. It is also important for the instructions to be in the correct order. This is also the case when programming.

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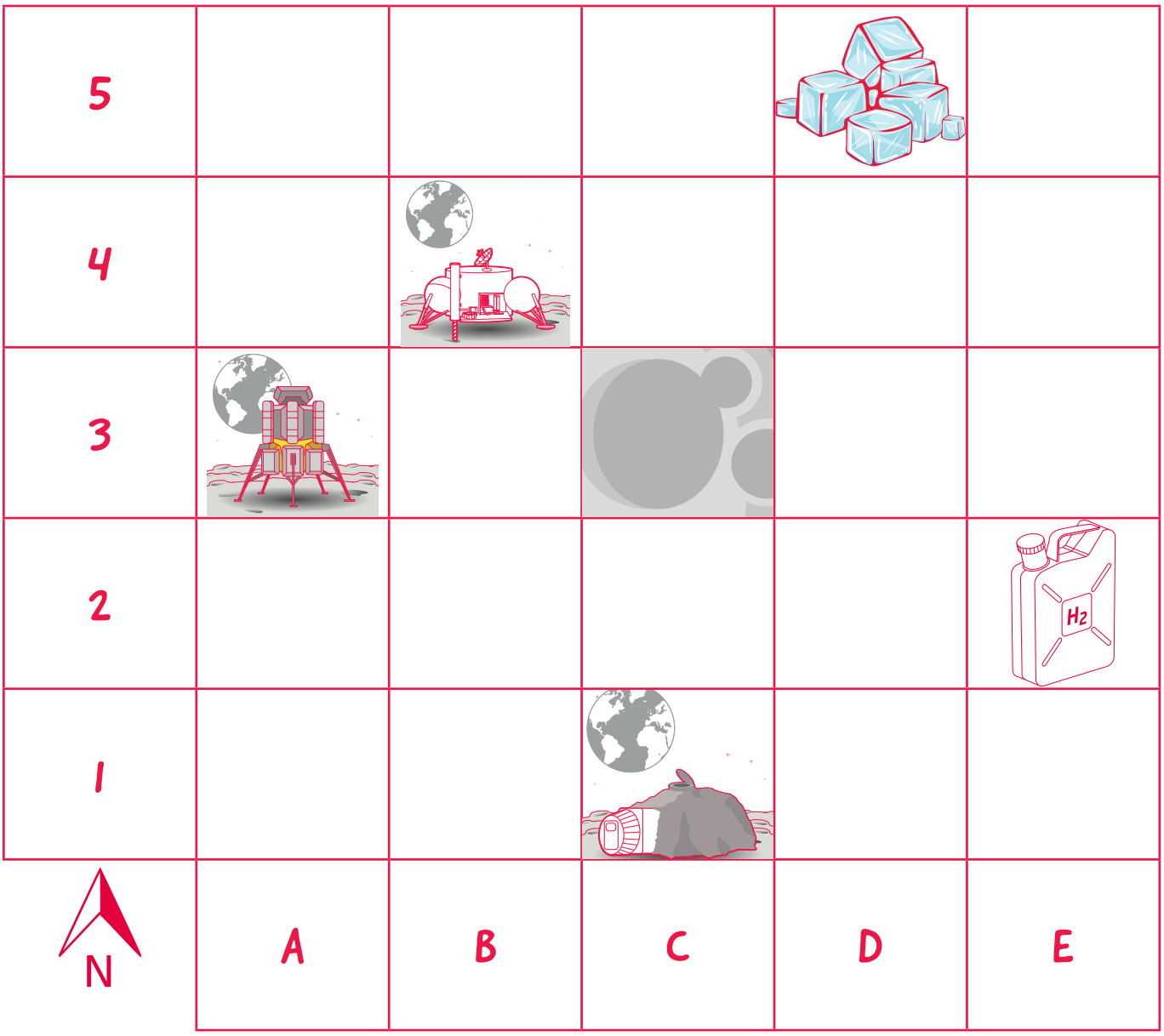
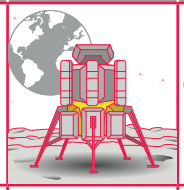
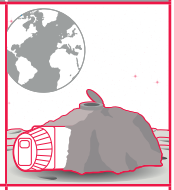
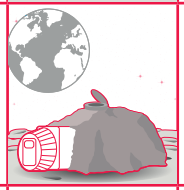
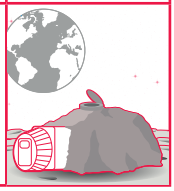
→ Activity 1: Mission planning

In this activity your task is to provide instructions for a rover to navigate across the lunar surface to complete a mission. You may only use the forward, turn right, turn left and turn around commands. Try to complete your mission using as few steps as possible.

Mission: Your rover has just landed on the Moon (A3) and it is facing North. Guide your rover from the landing site (A3) to the Moon base (C1). Then collect a water ice sample (D5) and return it to the base (C1). You must avoid the crater (C3).



Fill in the mission planning template below, using only the directions provided. The first line has been done for you.

MISSION	START	NUMBER OF MOVEMENTS										END
		1	2	3	4	5	6	7	8	9	10	
Mission 1: Landing site to the Moon base												
Mission 2: Moon base to collect ice sample												
Mission 3: Return to Moon base												

 Forward

 Turn around

 Turn left

 Turn right

→ Activity 2: Design and test your mission

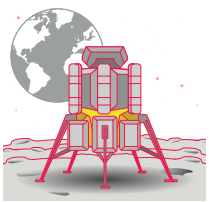
In this activity you and your classmate will play the roles of "mission controller" and "rover" on a Moon mission.

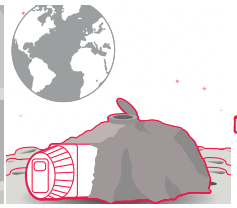
Exercise 1 – design your mission

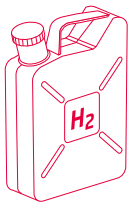
You will need to plan a mission on the Moon for your classmate. This mission will include completing various objectives while navigating unknown terrain before arriving safely at a final destination.

1. Place the different objective/hazard cards on the grid map and define your Moon Mission.

5					
4					
3					
2					
1					
N	A	B	C	D	E







2. Define your missions and complete the mission planning with the commands: forward, turn right, turn left and turn around.

MISSION	START	NUMBER OF MOVEMENTS										END
		1	2	3	4	5	6	7	8	9	10	

Forward

Turn around

Turn left

Turn right

Exercise 2 – test your mission

You will now take turns playing the roles of "mission controller" and "rover" in a human size lunar surface grid. When you are the mission controller you will direct your classmate (who will be blindfolded) to navigate through the mission you have planned and then you can swap roles. When directing your classmate you will have to be clear with your instructions and provide all the information they will need to carry out the mission successfully.

→ LINKS

ESA resources

Moon Camp Challenge
esa.int/Education/Moon_Camp

ESA classroom resources
esa.int/Education/Classroom_resources

ESA Kids
esa.int/kids

ESA space projects

ESA rovers tested in Tenerife
esa.int/Our_Activities/Space_Engineering_Technology/Rovers_drive_through_Tenerife_darkness

Landing on the Moon and returning home - Heracles robotic mission
esa.int/Our_Activities/Human_and_Robotic_Exploration/Exploration/Landing_on_the_Moon_and_returning_home_Heracles

Extra information

Video about tele-operating robots
https://lunarexploration.esa.int/#/explore/technology/228?ha=301&a=301

Video about how rovers could move on the Moon
https://lunarexploration.esa.int/#/explore/technology/228?ha=299&a=299

Global Exploration Roadmap
www.globalspaceexploration.org/wordpress/wp-content/isecg/GER_2018_small_mobile.pdf