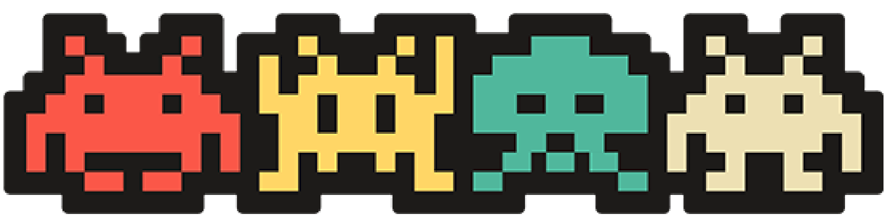
STEM education
ΟΡΓΑΝΙΣΜΟΣ ΕΚΠΑΙΔΕΥΤΙΚΗΣ ΡΟΜΠΟΤΙΚΗΣ, ΕΠΙΣΤΗΜΗΣ, ΤΕΧΝΟΛΟΓΙΑΣ & ΜΑΘΗΜΑΤΙΚΩΝ

International STEM Competition 2025

Category Regular
Beginners and Advanced

Can we survive on Mars?



Design: Konstantinos Tsatsaronis

Import

Mars is the most popular and familiar of the planets of our Solar System, as it is the closest to Earth after Venus, but also the one that most resembles it. Since the beginning of the 20th century, the possibility of hosting intelligent life forms, as argued by the American astronomer Percival Lowell, has passed from comics and literature to television and film, with a significant part of public opinion considering this not just possible but certain. At that time, of course, our knowledge of Mars was still minimal, since our technological capabilities did not allow us to clearly distinguish details on its surface.

The systematic study of the Red Planet, and at the same time the first scientifically documented refutation of Lowell's Martians, began in 1965 when Mariner 4, with its first close-up photographs, revealed a dead and frozen world, a world without vegetation and canals, without cities and Martians, a world hostile to life with polar temperatures. arid and deserted. Six years later, Mariner 9 was also embarking on its journey to Mars. His greatest discovery, and at the same time the first serious evidence of the existence of water on Mars in his past, was a vast system of cracks, faults, ravines and drainage channels. This giant fault has obvious traces of erosion from water that has long been lost.

Viking 1 and 2 continued exploring the Red Planet in 1976. About 21 years later, the Pathfinder mission carried Sojourner, the first robotic vehicle that could move on its surface, to the Red Planet, which chemically analyzed soil composition and collected weather data. In June 2003, the European Space Agency ESA launched the Mars Express orbiter to Mars, whose data helped astronomers explore fundamental questions about geology, atmosphere, water history and the possibility of microbial life. In March 2006, NASA launched the Mars Reconnaissance Orbiter (MRO). With the help of his data, scientists calculated that the north pole of the planet is covered by 821,000km3 of ice, while several more minerals were discovered that can only be formed by the influence of water. Two years later, NASA's Phoenix landed on Mars, which analyzed the chemical composition of soil and subsoil samples and confirmed the existence of subsurface ice by digging its icy surface with the help of its robotic arm.

The Curiosity rover, which landed on Mars in August 2012, is the largest and heaviest spacecraft to date to land on Mars. Its successful landing was a "gamble" for scientists, who wanted to find out whether it is possible and what difficulties hide the mission and landing of the much bulkier payloads that will be required in the future for its manned exploration. Curiosity's most important discoveries include the confirmation of the existence of carbon, oxygen, hydrogen, phosphorus and sulfur, the building blocks of life, as well as the existence of organic molecules. However, these discoveries in no way prove the existence of simple life forms on the Red Planet, neither now nor in the past. The MAVEN orbiter entered orbit around Mars in September 2014. The main goal of MAVEN's mission is to determine exactly how the planet's atmosphere and water have been lost over time. There are several ways in which a planet can lose some of its atmosphere. In the case of Mars, however, what is thought to have happened was the continuous erosion of its atmosphere by ultraviolet radiation

and solar wind. So far, MAVEN data confirm this scenario. Collecting and researching all this data, Mars looks colder than the Arctic and drier than the Sahara. However, we have discovered large amounts of ice and more recently dark lines that are likely formed by the seasonal flow of brackish water. According to all indications, billions of years ago, Mars was a much hotter and wetter planet with a dense atmosphere and water flowing into rivers and accumulating in lakes and seas.
The orbiters and robotic vehicles that landed on its surface continue to collect data, trying to find the answers, and at some point the first astronauts will walk on the surface of the Red Planet. The farther we aim into space, the greater the challenges and risks we will face. The longer a manned mission lasts, the more supplies it will have to carry, the better it will have to be shielded against harmful radiation and therefore the more weight it will have. The development and testing of the technologies necessary to build new, more powerful and efficient rockets and spacecraft has by no means been addressed, and the scientists and engineers working on these plans are not yet able to guarantee the safety of astronauts participating in long-duration missions in the future. Living astronauts in conditions of weightlessness for a long time causes muscle atrophy and osteoporosis. Their exposure to the dangerous radiation of solar flares and cosmic rays multiplies their risk of dying from cancer. This same risk will be faced by the first astronauts to set foot on Mars in the future, since this planet does not have an ozone shield and a planetary magnetic field that would protect them.
Survival on Mars requires a multifaceted approach that includes advanced technology, sustainable resource management, strong habitats, and integrated health and safety planning.

General Rules

The game will be played in 2 variants:

- A simpler one (Beginner), aimed at beginner learners.
- A more difficult one (Advanced), addressed to students who want to claim their participation in the World Educational Robotics Olympiad WRO 2025. This category is divided into three age groups, the boundaries of which are listed below.

Group Definition and Age Categories:

1. A group consists of 2 or 3 students.
2. A team is led by a coach.
3. A team with one member and one coach are not considered a team and cannot participate.
4. A team can only participate in one of the beginner or advanced categories.
5. Each student can participate in only one group.
6. The minimum coaching age is 18 years old.
7. Coaches can work with more than one team.
8. The age groups in the beginner category are:
    - students 8-16 years old (in season 2025: year of birth 2009-2017)
9. The age groups in the advanced category are:

- Primary school: students 8-12 years old (in season 2025: year of birth 2013-2017)
- High school: students 11-15 years old (in season 2025: born years 2010-2014)
- Lyceum: students aged 14-19 (in season 2025: born years 2006-2011)

10. The maximum age reflects the age reached by the participant in the calendar year of the race, not his/her age on the day of the race.

Permitted materials

- Teams are free to use any Microcontroller they wish, without any restrictions. The choice of motors and sensors also remains open. Each team can use only one microcontroller and <u>up to 4 motors</u>. There is no limit to the number of sensors.
- As building blocks for the construction of the robot, teams can use any material (e.g. wood, aluminum, paper, glue, lego bricks, 3d printing).
- For the programming of robots is allowed the use of any software and firmware.
- Teams must be equipped with the necessary software to plan their constructions. The program must be loaded into the robot before the competition starts.
- Teams should have with them all the necessary materials to assemble the robot, as well as additional materials they may need.

Instructions to groups

- All teams must be directed to the location indicated to them during registration, settle down and wait for the announcement of the start of the practice-testing time.
- It is forbidden for the coaches to enter the field and the test area throughout the match, as well as any communication between the teams and people outside the field without the permission and supervision of the judges.
- The Bluetooth and Wi-Fi functions of the teams' microcontrollers and laptops must be switched off throughout the race rounds.
- The teams will enter the competition with the robots assembled in advance.
- The maximum permissible size of the robot shall be 25x25x25 cm at the start of the test, excluding motor/sensor connection cables. During the test, there is no limitation on the size of the robot, provided that its projection is within the finish block after stopping (not including motor/sensor connection cables) if requested.
- Before each race round begins, teams will be given time to test on the track. Teams form a priority order for their tests. During the tests:
    - Members of the same group are not allowed to reserve different positions in the order of priority. In order for someone to have a place in the priority order, he must hold the robot of his team.
    - Teams are not allowed to bring their laptops or tablets to the track during testing. Any change in their schedule should be made at their table and before bringing the robot for testing.

  - Teams are not allowed to bring their own tracks to the race ground.
  - Teams must calibrate their robots during testing and only then.
- Before testing time ends, teams must place their robots in quarantine. A robot that is not delivered on time cannot participate in the corresponding round. The robot must have only one executable program (including subprograms belonging to a base program). The judges must be able to clearly identify the executable program in the robot. The teams inform the judges of the name of their program during quarantine. The name will be written on the quarantine robot's storage area, and only this program can be performed by the team. If there is no program in the robot, the team cannot participate in this race round and is disqualified for this attempt.
- Once the test time is up, the judges prepare the track for the next race lap and the robot's control time begins. The teams hand over the robots for dimensional control to the judges. In the event that the robot is larger than the permissible size, five minutes are given time to correct the dimensions. If conversion is not possible, the robot cannot race and is reset for this racing round.
- The robot must be placed in the starting area so that its vertical projection is entirely inside the starting area, with the orientation desired by the contestants. The time of the test begins when the judge gives the appropriate signal. It is not allowed to pass data to the program either by rotating pieces of the robot, or changing the starting position of the robot, or in any other way. If such settings are recognized by the judge, then the team will be asked to explain the strategy followed by its algorithm.
- Contestants must wait for the judge's signal to set the robot in motion.
  - In case the start of a program directly sets the robot in motion, the team must wait for the judge's signal before starting the program.
  - In case starting a program does not immediately set the robot in motion, the team is allowed to start the program before the start signal. After the start signal from the judge, it may be set in motion by pressing the central button on the controller. No other buttons or sensors are allowed to start the robot. In any case, the button that sets the robot in motion should be given and known to the judges before the start of the race round.
- Team members are not allowed to touch the challenge track or robot during each race lap.
- The maximum execution time of each mission by the robot is set at 2 minutes.
- The robot can leave on the track track(s) that do not contain its main parts (controller, motors, sensors). If such a piece touches the track or elements of the challenge and does not touch the robot, then it is not considered as part of the robot.
- A robot's effort ends when:

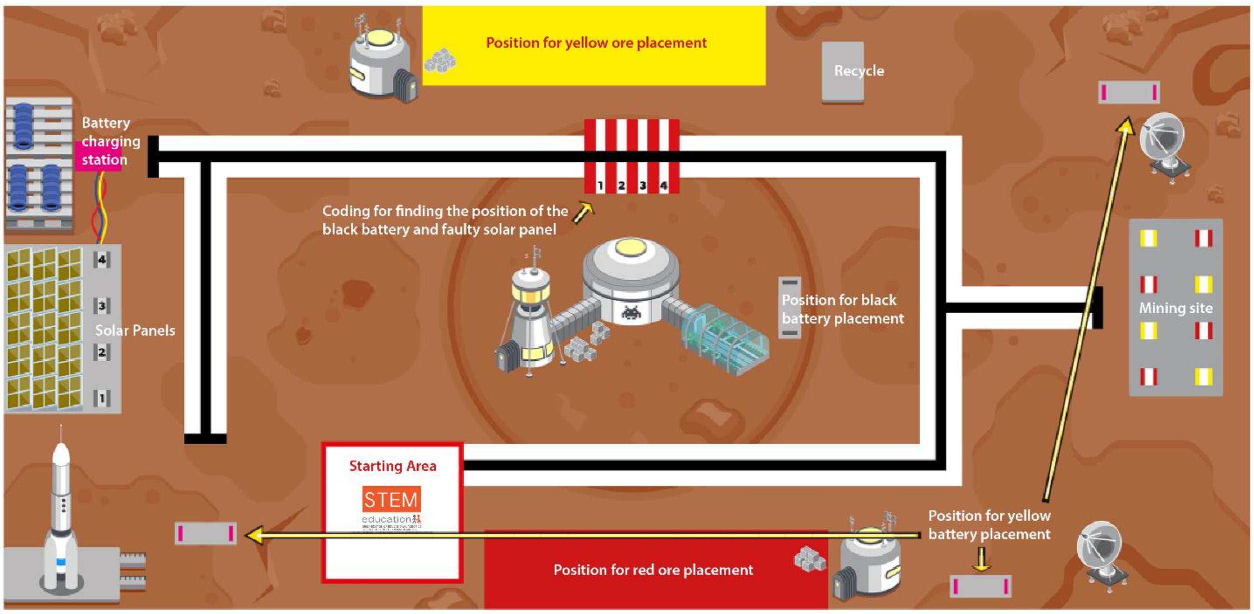
- The time to solve the challenge (2 minutes) is up. If after the end of the year the robot is still moving on the track, then the points collected after 2 minutes will not be taken into account when scoring.
- Any team member who touches the robot or any object on the track during the execution of the program.
- The robot has completely left the track.
- the robot or team violated rules or regulations.
- a team member shouts "STOP" and the robot doesn't move anymore. If the robot moves, the effort ends when the robot stops on its own or is stopped by the team or the judge.

Then the judge enters the score and the time on the corresponding score sheet.

- The judge chooses whether to cancel the attempt or to rate a part of it by charging 2 minutes if:
  - Any member of the team touches the robot during the competition without the permission of the judge.
  - There is a violation of the rules of the challenge.
  - If a team completes an attempt without having scored a single point.
- The calculation of the score and time is announced by the judges at the end of each competitive round. A team member signs the time-score acceptance form. Once signed, no further termination is possible.
- If there is any uncertainty about the scoring during the challenge, the judge makes the final decision, in cooperation with the organizing committee, and announces it to the team. Coaches participate in this process only if they are allowed by the organizing committee.
- Regional competitions allow two identical robots to participate, regardless of trainer, while identical robots are not allowed in the final competition. If identical robots are suspected during the final, the organizing committee will investigate whether the teams are using identical robots not only in terms of construction but also in terms of programming and will announce which ones meet the requirements to compete, which will be disqualified for one or more rounds, which will compete with a penalty of 50% of the score obtained or which will be eliminated altogether.

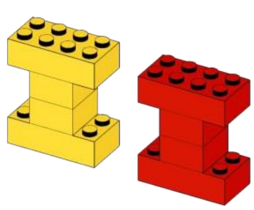
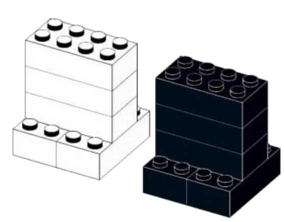
Game Track

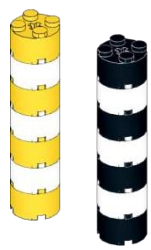
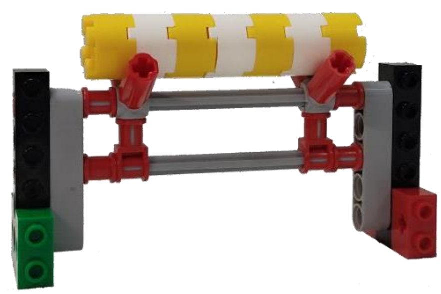
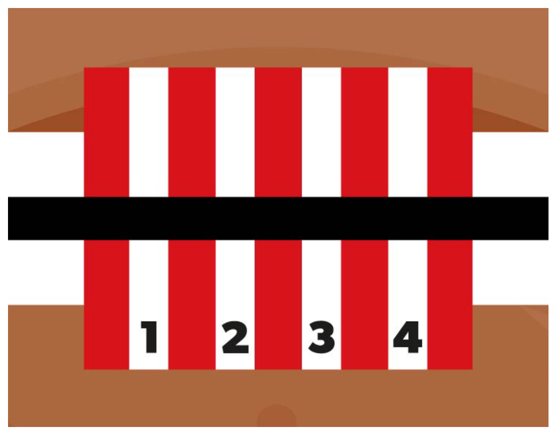
For the convenience of the teams, the dimensions of the game track remain the same as those of the WRO Robotics Olympiad (2362 mmx 1143 mm). The figure below shows the plan of the track and the areas that make it up.



Objects of the Track

The following items are used in the game:

 Ores (four yellow and four red)	 Solar panels (three white and one black)

 Batteries (three yellow and one black)	 Battery charging station
 Battery mounting location	 Pre-draw encoding area

Game Description

The teams' mission is to build and program autonomous robots that can safely navigate the surface of the Red Planet and perform various missions that can help humans survive on Mars.
When starting, the robot should be completely within the starting area (25cmx 25cm). Wires are allowed to protrude.
The missions that the robot must perform on the track are described in detail below:

Mission 1: Transportation of ores.

Ongoing research on Mars, such as geology and potential hazards, is crucial. Robotic missions can help identify and collect data before human arrival.
For this reason, the robot's mission is to transport and classify various ores from the mine area to the respective deposition and exploration sites. (Yellow and red ore laying area).
The yellow and red ores are placed in their respective positions, in the mine area, defined by the respective yellow and red frames and tangent to the white line of the frame. The robot should

transport the yellow ores to the yellow region and the red ores to the red area. After transportation and classification, they do not need to be in an upright position, as long as their projection is within the ore placement area.

This mission is common to all groups. That is, it should be performed by both the teams participating in the beginners category and the teams participating in the advanced category.

Mission 2: Solar panel repair.

Solar panels can provide energy, although they must be designed to withstand dust storms that can reduce their performance.

The mission of our robot is to find and transport the defective solar panel (black color) to the recycling area so that the charging station can continue to be supplied with electricity produced by the other panels (white color).

All four solar panels (3 white and one black) are mounted on the grey numbered panels and their orientation is defined by the white line within the frame.

- For teams participating in the beginners' category, the defective panel (black color) will have a predetermined position and will be placed in the gray box number 3.
- For teams participating in the advanced category, the defective panel (black) will be placed in the grey box whose number will be determined by the Position Coding Area as in the case of Mission 3: (Battery Transport).

After transport, the defective panel does not need to be in an upright position, as long as its projection is within the recycling area.

Mission 3: Battery Transportation.

(This mission is intended only for advanced groups)

The robot's mission is to transport four batteries from the charging station to our colony's facilities on Mars. The batteries will be placed in the special battery placement positions located at specific points on the track and must not be in contact with it. One of the batteries is black in color and the position to be installed is specific and indicated in the description of the track (p. 7).

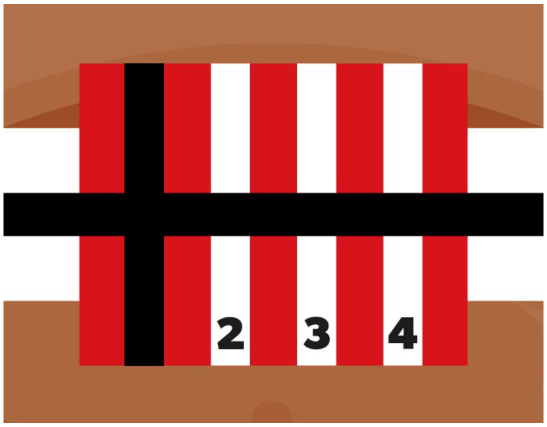
The battery charging station will be glued to the track and the four batteries will be inside it. The output order of the black battery will be determined by the Position Coding Area as follows:

The 4 white lines numbered 1, 2, 3 and 4 will be glued after drawing lots black lines (insulating tapes about 19mm thick). There are the following cases.

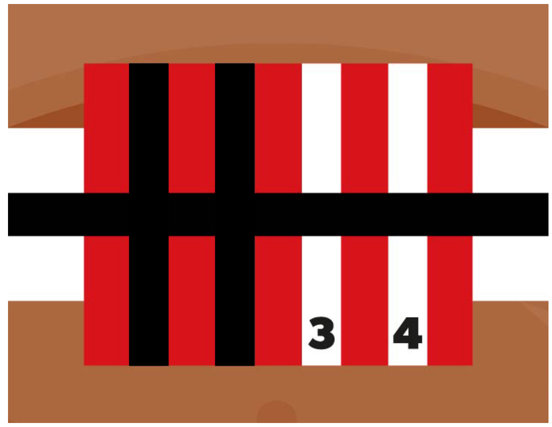
- If there is only a black line at position 1, then the output order of the black battery will be first.
- If there are two black lines (in positions 1 and 2), then the output order of the black battery will be second.
- If there are three black lines (in positions 1, 2 and 3), then the output order of the black battery will be third.

- If there are four black lines (in positions 1, 2, 3 and 4), then the output order of the black battery will be fourth.

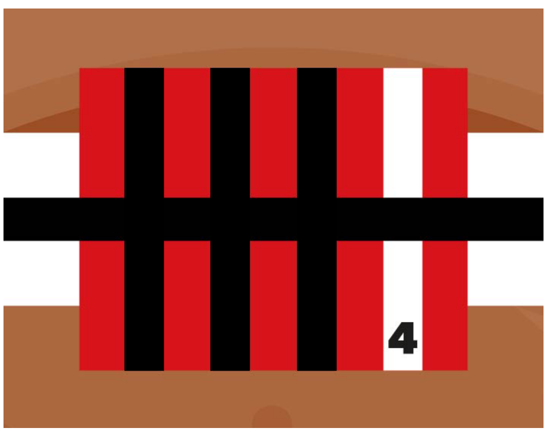
The images below illustrate these cases.



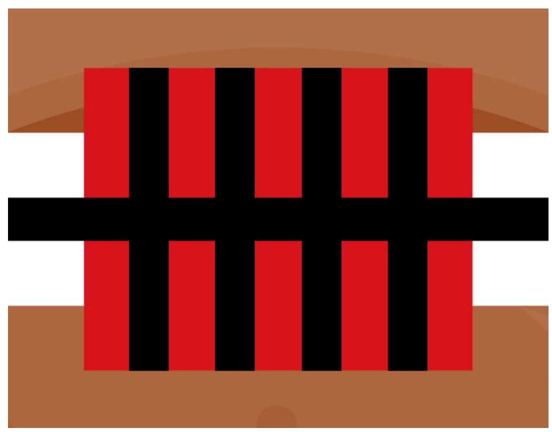
Draw of position 1



Draw of place 2



Draw of place 3



Draw of place 4

Beginners Leaderboard

The teams will be scored according to the table below. In addition, the points of the surprise rule will be added on the day of the finals.

Beginners Rating	**Points**	**Total. Points**
Yellow ores (4) are located within the yellow range. Fully Yellow ores (4) are located within the yellow range. Partially	15 5	60

Red ores (4) are located within the red region. Fully Red ores (4) are located within the red region. Partially	15 5	60
The defective panel (1 black) has been moved to the recycling area. Fully The defective panel (1 black) has been moved to the recycling area. Partially	15 5	15
The functional panels (3 white) are in place and the defective (black) has been removed.	5	15
Maximum Beginner Rating		**150**

Beginner Team Ranking

The ranking of the teams is defined as follows:

- Best effort points
- Best 2nd attempt points
- 3rd best effort points
- Although after the above three criteria there are ties, the teams are ranked in the same position.

Advanced Leaderboard

The teams will be scored according to the table below. In addition, the points of the surprise rule will be added on the day of the finals.

Advanced Rating	**Points**	**Total. Points**
Yellow ores (4) are located within the yellow range. Fully Yellow ores (4) are located within the yellow range. Partially	15 5	60
Red ores (4) are located within the red region. Fully Red ores (4) are located within the red region. Partially	15 5	60
The defective panel (1 black) has been moved to the recycling area. Fully The defective panel (1 black) has been moved to the recycling area. Partially	15 5	15
The functional panels (3 white) are in place and the defective (black) has been removed.	5	15
The yellow battery (3) is in the correct position. The yellow battery (3) is in the wrong position.	15 5	45
The black battery (1) is in the correct position. The black battery (1) is in the wrong position.	25 5	25
Maximum Advanced Score		**220**

Advanced Team Ranking

The ranking of the teams is defined as follows:

- Best effort points
- Best effort time
- Best 2nd attempt points
- 2nd best effort time
- 3rd best effort points
- 3rd best effort time
- Although after the above criteria there are ties, the teams are ranked in the same position.

Assembly Instructions

The instructions for assembling the challenge items will be posted soon.