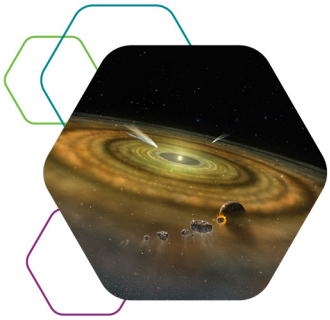


FACILITATOR GUIDE
Explore Mars! A Rover Game

Learning Objectives

Learners who play this game will explore these main ideas:

1. Scientists rely on unmanned, robotic rovers that are controlled on Earth to explore the surface of Mars.
2. Space exploration requires a diverse team of experts that collaborate to accomplish a space mission goal.
3. Scientists are interested in finding signs of ancient microbial life on Mars.

In addition, learners will practice collaboration.

Overview

You are a team of experts at Mission Control here on Earth. You will work together to program and communicate with a rover on Mars to successfully complete its mission. You must program the rover to collect four data samples from Mars and send the data back to Earth before the treacherous environment damages the rover beyond repair. Through your hard work, the rover will test new technologies that will pave the way for future human exploration of Mars!

Best of luck!

2–5 players | 8 yrs+ | 30–45 minutes

Materials

Nearly all the materials for this program are collected into five print-ready graphic files that can be downloaded for free from www.nisenet.org. Each file contains instructions for printing and cutting to size.

Game pieces:

- 1 Rover Programming Console board
- 61 cards, divided as follows:
  36 Event cards:
  5 Mars Fact
  8 Program Error
  5 Rover wheel damage
  2 Software update
  2 Communication blackout
  3 Rover sleep mode
  3 Shortcut
  1 Solar-powered drone
  3 Autopilot
  3 Reprogram navigation
  1 Laser micro-imager
  28 Command cards:
  6 Up
  6 Down
  6 Left
  6 Right
  3 Shortcut
  1 "</run>" Command
  6 Mission Control collaborator cards
- 25 double-sided Mars tiles
- 4 double-sided hazardous terrain tiles (2 sand dune, 2 steep terrain)
- 4 Data sample tokens (geologic data, oxygen production, subsurface ice, signs of microbial life)
- 1 Container token
- 1 Rover pawn
- 1 paper clip

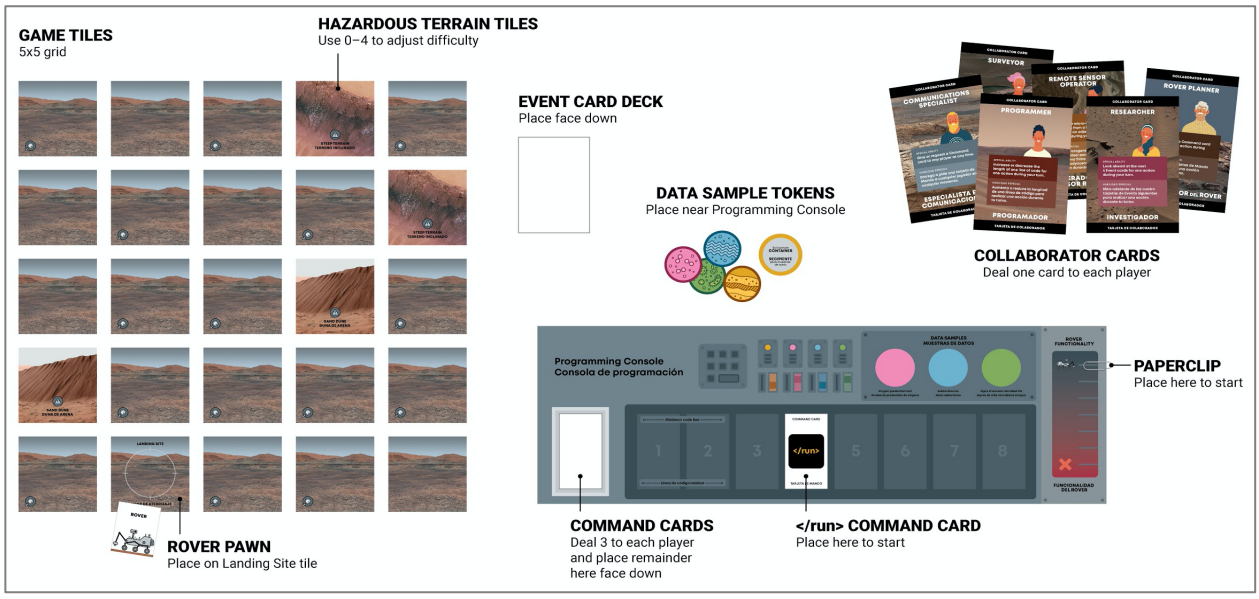
Optional: If you would like to incorporate three-dimensional pieces, you can download a 3D print file for the rover and the four data tokens and use a 3D printer to create them:

3D Rover print file https://nasa3d.arc.nasa.gov/detail/M2020-Model-Rover-STLs512020
3D Drone print file https://nasa3d.arc.nasa.gov/detail/ingenuity_thumb

Advance Preparation

1. Print the game materials following the instructions in the files. You may want to use cardstock or laminate the components for durability.
2. Set up the game using the illustration below for reference.
3. Thoroughly read the game instructions and play through the game to understand the flow and mechanics.

Game setup



Create the Martian surface

The playing surface is made up of 25 double-sided Mars tiles, set up in a 5x5 grid. To begin, decide how challenging you want the game to be. For easier play, keep all 4 double-sided blank Mars tiles in your deck of 25. To make the game more difficult, replace 1, 2, 3, or 4 of the blank tiles with hazardous terrain tiles. The more hazardous terrain tiles you place, the more difficult the game will be, because the rover cannot travel through the hazardous terrain tiles and must go around them. (Do not replace any of the tiles that have magnifying glass icons. These are necessary for the game.)

Randomly shuffle the 25 double-sided Mars tiles and lay them out in a 5x5 grid with the Mars landscape sides facing up. Place the rover pawn on the landing site.

Divide the cards and set the command board

- Shuffle and set the Event cards facing down next to the Mars tiles grid.
- Set the Rover Programming Console next to the grid and place the "</run>" card on the designated starting space.
- Set the four sample data markers near the Programming Console.
- Shuffle and set the Command cards on the designated space on the console.
- Shuffle and randomly hand each player a Collaborator card. Invite each player to share their character and special ability.
- Shuffle and hand out 3 Command cards to each player. These cards should remain visible to the entire group because you are working together on this mission!
- Place a paperclip at the top of the Rover Functionality indicator on the console. (You'll move the paperclip later if your rover is damaged.)

Instructions for Playing

Object of the game

The object of the game is to collect all four data sample data tokens, then move the rover to the tile that says, "Send data to orbiter." To collect the tokens, players "program" the rover with the Command cards to move about the tiles (Martian terrain). The rover cannot move through hazardous terrain (sand dunes and steep terrain). The tiles with a magnifying glass icon need to be researched (flipped over) during game play in order to locate where the rover can collect data. Players must avoid damaging the rover wheels beyond functionality or corrupting the rover's programming code.

Overview and introductory script

Start the game by explaining the mission. You can jump right in after a short introduction or provide a longer introduction to set the mood and help the players get into character. Suggested scripts are provided here.

Short introduction:

You are a team of experts at Mission Control here on Earth. You will work together to program and communicate with a rover on Mars to successfully complete its mission. You must program the rover to collect four data samples from Mars and send the data back to Earth before the treacherous environment damages the rover beyond repair. Through your hard work, the rover will test new technologies that will pave the way for future human exploration of Mars!

Best of luck!

Longer introduction:

Congratulations! You have been chosen as a team of experts at Mission Control here on Earth. As a team, you are charged with operating a rover on Mars. Collectively, your team must work to maneuver the rover without falling prey to the many hazards on Mars.

A harsh environment awaits you. Can you program the rover to collect data and samples at four areas of interest and send the data to the orbiter before the treacherous environment damages the rover beyond repair? If you fail to do so, the mission is over! However, if you are successful, the rover will collect crucial data, intriguing rock samples, and perhaps signs of ancient microbial life!

Your mission awaits!

[PAUSE AND THEN BEGIN A DRAMATIC COUNTDOWN]

Mission Control experts, the countdown for your rover's mission to Mars is underway.

T minus 31 seconds and counting!

It takes a diverse group of experts working together from Earth to control a rover on Mars.

T minus 16 seconds!

You and your team must watch out for treacherous terrain around every corner and ensure your rover isn't damaged by the harsh environment.

T minus 10 seconds!

As a team of experts, you will program and communicate with the rover as you search for signs of ancient microbial life.

T minus 6 seconds!

Your rover needs to collect data and samples from four areas of interest and make it back to the landing site with your rover intact.

T minus 0!

Solid rocket booster ignition and liftoff!

Order of play

To decide who goes first, everyone names the place they have been that is farthest from their home, and the person who has traveled the farthest goes first. (For example, if three players in Minnesota have been to Washington DC, Mexico, and Antarctica, the player who has been to Antarctica goes first.) You can modify this rule as needed; for example, the youngest player could go first. After you decide who goes first, then play continues to the left.

Game play

On every turn, players do the following in order:

1. **Take up to three actions**
2. **Draw an Event card**

Take up to three actions

You may take up to three actions per turn (0, 1, 2, or 3 actions). Your teammates are encouraged to give you advice on the best actions to take during your turn. Remember, you're working together to win.

You can select a combination of any of the following actions:

- Draw, request, or give a Command card
- Program the console
- Run program
- Research a tile
- Collect a data token
- Use a special ability

You can repeat actions; for example, your three actions can be drawing three Command cards.

Draw, request, or give a Command card:

You may draw a card from the deck, request a Command card from another player, or give a card to another player. You may hold up to 5 Command cards at a time. If you hold more than 5 Command cards, you will discard the drawn Command card or discard one of your other Command cards. Each card drawn, requested, or given is one action. When you read the Command cards, be sure they are oriented the same way as the tile grid (they're right side up).

Program the console:

For one action, you may program the console with a Command card by placing a Command card in the first open spot, moving from left to right. Each card placement is one action. Avoid completely filling up the Programming Console, or you will corrupt the code and the rover will malfunction beyond repair!

Run program:
The rover can only move after the console has been programmed up to the "</run>" Command card. Before you can "run" the code, you must have at least two Command cards placed on the console and there cannot be any gaps between the code and the </run> command.

- *Exceptions to the rule:* If you have a "shortcut" Command card, you may run the code with only one command. If you are holding an "autopilot" Event card, the rover can move one tile in any direction on its own.
- *Note:* For one action, the </run> Command card can be moved by the Programmer during the Programmer's turn.

This is a complete command, so the rover can move:

This is an incomplete command.
There is a gap between the code and the </run> command, so the rover cannot move:

The Shortcut card allows the code to run immediately.
With this card, the rover can move even if there is only one command:

After the code has been run, move the rover to the desired location, then clear and discard the Command cards, excluding the </run> card, which will remain on its current location on the programming console.

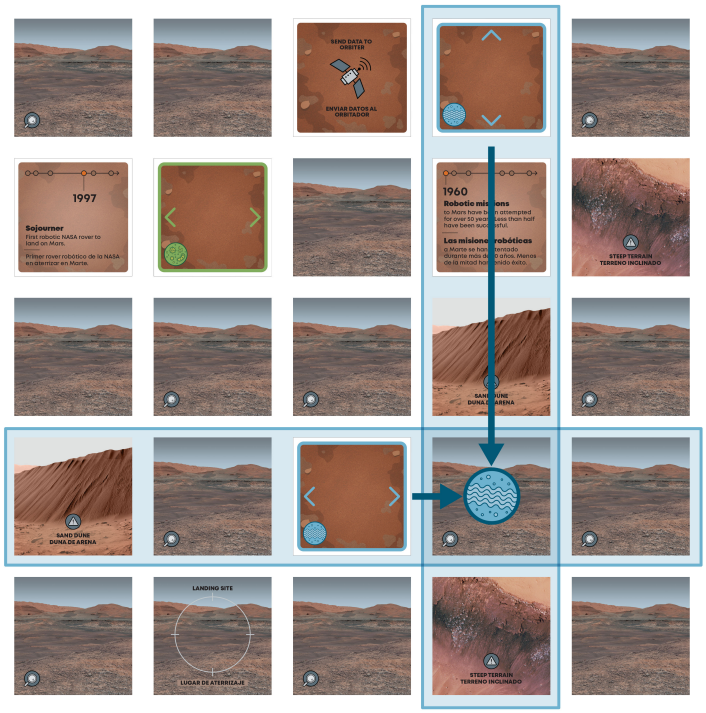
Research a tile:

To research a tile, travel to the tile and flip it over.

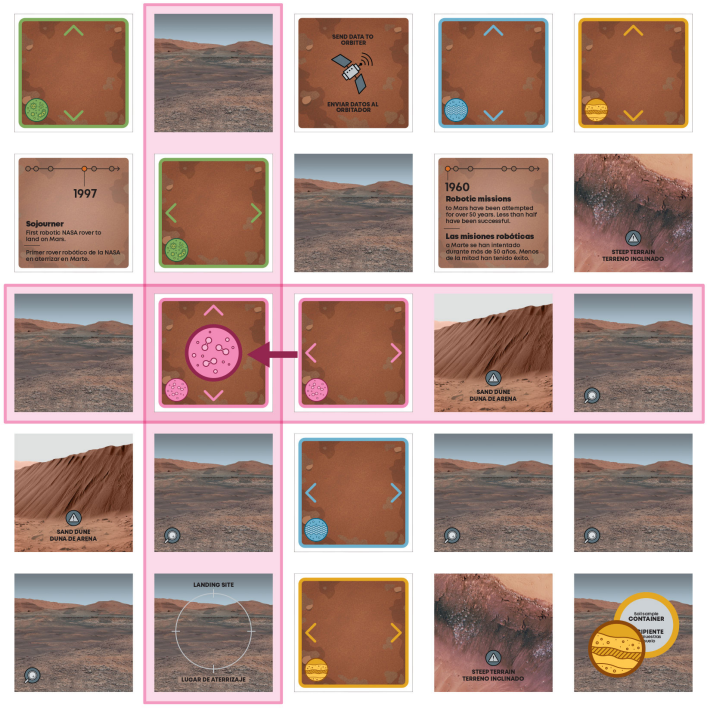
Collect a data token:

To collect a data token, you must first find the data location. The data location clues are hidden beneath the Martian surface. These can be identified by “researching” the tiles that have the magnifying glass icons located on the lower right corner of the Martian tiles. One clue indicates the row (the RIGHT/LEFT direction) and the other clue indicates the column (the UP/DOWN direction) where the data can be found. When you reveal the coordinating clues, place the coordinating data token on the tile where the row and column intersect. (This does not count as an action.) See the illustrations for more information on how to find the data locations.

Flip over the magnifying glass tiles and follow the directional arrows.
Place the data token on the tile where the lines intersect:



Sometimes, the two coordinating clues end up being side by side. When this happens, one tile arrow is pointing to the other tile. That tile is where the token will go:



Once you have found the data location, travel to the tile to collect the token. If your data is oxygen production, subsurface ice, or signs of microbial life, place the token on the Programming Console. If your sample is geologic data, leave it where you found it.

Special note: Once you have collected all four tokens, you'll also need to reveal the tile that says, "Send data to orbiter." Travel to that location, and the three samples at the console will be sent back to Earth, while the geologic data will remain on Mars until a future Rover returns for it. When you have done this, you have won the game!

Use a special ability

Each player has a special ability that can be used as one action during a turn. This ability is explained on the Collaborator card. There is no limit to the number of times a player can use a special ability.

Draw an Event card

On each turn, after taking up to three actions, players will draw an Event card. Reveal the card to the group and follow the directions on the card. After you have followed the directions, discard the card in a separate pile, unless it is a card that you can keep and use later.

The Event cards are color-coded into three categories: red cards that cause damage or inhibit the mission, blue cards that will help the mission, and tan cards that provide an interesting fact about Mars. *Note:* Some of the Event cards may not be useful, depending on which characters are playing or how the tiles randomly sit in the grid.

The following are the types of cards that are in the Event card deck:

- Autopilot: Autopilot allows the rover to perform mission-critical tasks on its own. Use this card to move one tile in any direction. Discard after use.
- Coding Shortcut: You've learned a shortcut for faster code. Use this card at any time to decrease up to two lines of code by moving the </run> card on the console. You will hold on to this card to be used in a time of need; for example, when the line of code is too long to go to a location you want to search, or the code is in danger of getting too long and becoming corrupt. Discard after use.
- Communication Blackout: Dust storm blocks communication to the orbiter. Skip the next player's full turn.
- Laser Micro-imager: Use this card to capture data from either an adjacent tile or a hazardous tile for one action during your turn. You can hold on to this tile to be used at a time of need; for example, when the Remote Sensor Operator character is not playing and you need to collect data from a hazardous terrain tile. Other players can still use this card even if the Remote Sensor Operator is playing. This card may be shuffled back into the deck after use.
- Mars Fact: You lucked out! Nothing happens to your rover and now your whole team learned a new fact!
- Program Error: Add one line of code to the Programming Console by moving the </run> card to the right, one space.
- Reprogram Navigation: Use this card to view the top four Command cards and change their order at any time. Discard after use.
- Research: Look ahead at the top four Event cards and change their order for one action during your turn. Discard after use.
- Rover Wheel Damage: Decrease rover wheel functionality by moving the paperclip marker on the Rover Wheel Damage down one position.
- Rover Sleep Mode: The rover goes into sleep mode to recharge. Skip drawing an Event card. You will hold on to this to be used in a time of need; for example, when you are close to the end of the game and you don't want to risk drawing an Event card that causes damage to the rover. Discard after use.
- Software Update: The next player will draw two Event cards on their next turn.

- Solar-powered Drone: At any time, you can look under four adjacent tiles OR "fly" to any one tile to look under for researchable data. Discard after use. You can hold on to this card to be used in a time of need.

Ending the game

Winning: Once you have retrieved all four sample data tokens, move the rover to the tile that says, "Send data to orbiter." The orbiter is flying around Mars and will send the data back to Earth for the win! (The geologic data is safely cached on Mars, waiting for the next rover to collect it.)

Losing: There are two ways to lose the game. The rover wheels can become damaged beyond functionality, or the Programming Console can completely fill up, meaning the code is corrupt and the rover malfunctions beyond repair. Missions don't always go according to plan!

Notes to the Presenter

About the game

Explore Mars! A Rover Game is designed as a hands-on game for STEM learning in museums and planetariums. This game is also suitable for use in other informal learning settings such as afterschool programs, summer camps, libraries, scouting groups, community organizations, and university public outreach programs. It may also be adapted by educators for use in formal education K–12 classrooms.

This game is intended to be played live and in person by 2–5 participants, with support from a museum educator or volunteer facilitating the game. It is best suited for players 8 years old and older. You can simplify the game for younger learners (see below).

The game is grounded in real science about a mission on Mars. The emphasis in this game is to work together to have the most successful mission. All NASA missions require teamwork! This material has been reviewed by NASA scientists working on Mars missions, as well as experts on interactive games in informal learning environments.

Adaptations for early learners

Is the core game a bit too advanced for your young learner? Try some of these adaptations, or make your own. As long as your group is having fun, there is no wrong way to play!

Simplified game board and rules:

Altered grid: 4x4 grid of tiles. All tiles are search sites and one non-searchable site. No hazardous terrain tiles are in play. As younger children have a shorter attention span, this reduces the play time and simplifies the game.

Simplified mechanics:

Omit the collaborator cards. This could be a suggestion for learning the flow of the game for

young learners. When they are ready for something more complex, they can add in Collaborator cards. Otherwise there may be too many rules for them to learn at once.

Keep the Programming Console "locked" in place:

The </run> card will stay in its place instead of moving throughout the game. This will remove the most abstract strategic element of the game. Depending on their age, young learners do better with simple and static rules, rather than rules they can change depending on their situation in the game.

Command cards:

Players may turn the Command card arrows any direction rather than right side up. This simplifies the actions of creating the program that moves the rovers.

Conversational prompts

Some of the Event cards and Mars tiles contain interesting facts about Mars and missions on Mars (past and present). Use these facts to spark conversations about why humans want to go to Mars and what they want to learn about the planet.

You can also talk about the special hazards of doing research on Mars. The game includes hazardous terrain tiles (steep terrain and sand dunes). In real life, these types of hazardous terrains on Mars prevent rovers from traveling to certain places to collect data.

Safety

Advance preparation: After printing the game pieces, use caution while cutting the cards and other components of the game with scissors or paper cutter.

Program delivery: Keep an eye on young children at all times while playing this game. Be sure they do not place game pieces in their mouth.

Credits and Rights

This material is based on work supported by NASA under cooperative agreement award number 80NSSC18M0061. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Aeronautics and Space Administration (NASA).

Elements of this game were inspired by the Forbidden Desert board game by Gamewright.
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Images of Mars landscape are courtesy of NASA.
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