TAKE ME HOME, MARTIAN ROADS

TEAMWORK AND COMMUNICATION

MISSION DESCRIPTION

The Mars All-Terrain Transporter (MATT) rover is caught in a heavy dust storm during a sample-return mission on the red planet. Unfortunately the storm scattered the samples the rover collected and destroyed its navigation systems. A window of communication between MATT, the rover operator, and the navigation team is approaching. The operator is the only one who can control the MATT rover, but the operator cannot see it and is in a different location from the navigation team. The navigation team can see the rover, but not operate it. The navigation team must work together to instruct the operator with specific movements for the rover in order to collect the samples, avoid danger, and return to the Mars base.

Participants can be divided into small teams. Each team will have one MATT rover operator and a navigation team. The navigation team will communicate rover movement instructions to the operator, and the operator will navigate the rover image through the map according to those instructions. The goals are to avoid dangerous spots on Mars, retrieve important samples, and return the rover to the Mars base within a communication window of 5 minutes.

TIMELINE

Breakdown	**Duration**
Introduction and team assignments	5 minutes
Explanation of rules and activity purpose	10 minutes
Navigation team pre-activity discussion*	2 minutes
Activity	5 minutes
Group reflection	10 minutes
Total	**35 minutes**

*To increase difficulty, reduce discussion to 1 minute.

Difficulty: **EASY**

Duration: **35 MINUTES**

Materials: **MINIMAL**

GOALS

Participants will learn how to effectively communicate under pressure and within a time constraint.

OBJECTIVES

By the end of the activity, participants will be able to:

- Describe at least one way they had to adapt their communication style to complete the activity
- Describe at least one thing they learned from this activity

BACKGROUND

Effective communication and teamwork abilities are critical in the space sector. Mission control personnel need to communicate clearly and concisely with colleagues and the crew on the International Space Station (ISS), and the ISS crew need to follow precise operation commands while conducting experiments, performing spacewalks, conducting interviews, and much more!

On Mars, communication will be much more difficult. Depending on the position of the planets, there can be up to a 20-minute communication delay between Earth and Mars. That means it could take 20 minutes to send a command and 20 minutes to receive a response. As humans move deeper into space, effective communication and teamwork are critical!

Canadian Space Agency astronaut David Saint-Jacques acting as the capsule communicator, or capcom, at NASA's Mission Control Center in Houston, Texas. Credit: NASA/Douglas Wheelock

MISSION PREPARATION

MATERIALS

- Instructions for Navigation Team (see participant handout 1)
- Map for Navigation Team (see participant handout 1)
- Instructions for Operators (see participant handout 2)
- Map for Operators (see participant handout 2)
- MATT Rover Image (see participant handout 2)
- Appendix (see PDF)

REFLECTION

The educator may guide post-activity reflection by asking open-ended questions.

For example:

- Did your team experience communication challenges during the activity? If so, how did you work together to overcome them?

PARTICIPANT HANDOUT 1

INSTRUCTIONS FOR NAVIGATION TEAM

Your team needs to provide the operator with movement instructions to retrieve all five samples and deliver the MATT rover safely to the Mars base. Communicate with everyone on the navigation team to decide the best way to communicate with the operator. Ensure you are in view of the operator's map, but make sure the operator cannot see you. The movements will be in relation to the rover's arrow. **You have five minutes to complete this mission.**

APPROVED COMMANDS

- Rotate 90 degrees clockwise
- Rotate 90 degrees counter-clockwise
- Rotate 180 degrees
- Move "#" spaces forwards
- Move "#" spaces backwards
- Retrieve the _____ sample within the square
- Affirmative
- Negative
- Rover destroyed; move to starting square

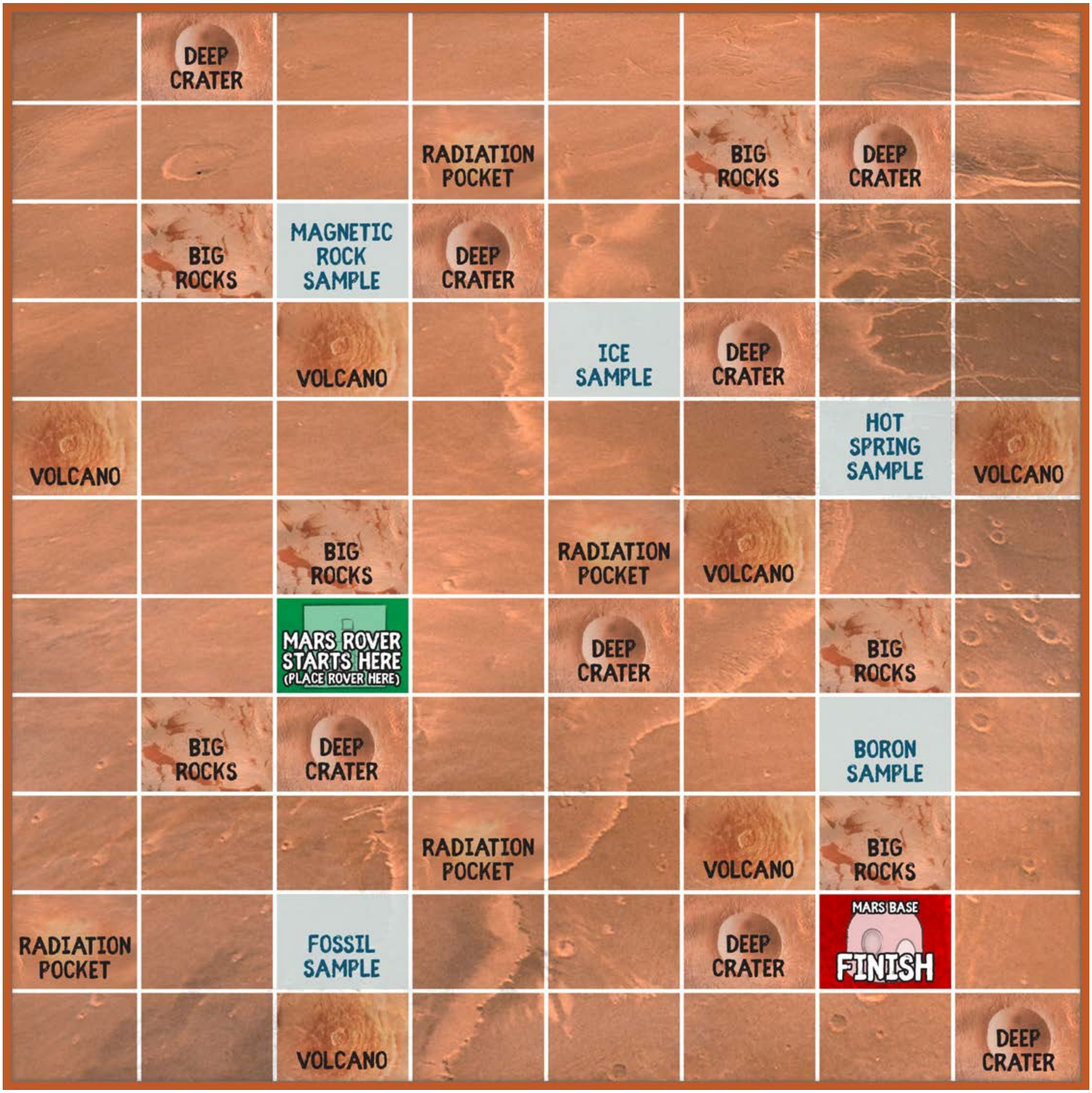
The rover cannot be moved diagonally.

RULES

1. See which direction the rover's arrow is facing; your instructed movements will be in relation to the rover's arrow.
2. Only one teammate can speak at a time.
3. The teammate cannot be interrupted, even if they give an incorrect instruction.
4. Teammates must take turns giving instructions.

   Example: Teammate 1 says, "turn 90 degrees clockwise"; teammate 2 says, "move forward by 3 squares"; and teammate 3 says, "retrieve sample within square."
5. You cannot say "You are going the wrong way" or anything similar unless specifically asked by the operator.
6. If you are asked a question by the operator, you must **wait 10 seconds before responding.**
7. If the operator forgets to retrieve a sample, you must instruct the operator back to the sample and tell him/her to retrieve it. The operator will write an "X" to indicate retrieval.
8. If the operator goes into a danger square (deep crater, volcano, radiation pocket, or big rocks) you must end the game and restart if time permits.

MAP FOR NAVIGATION TEAM

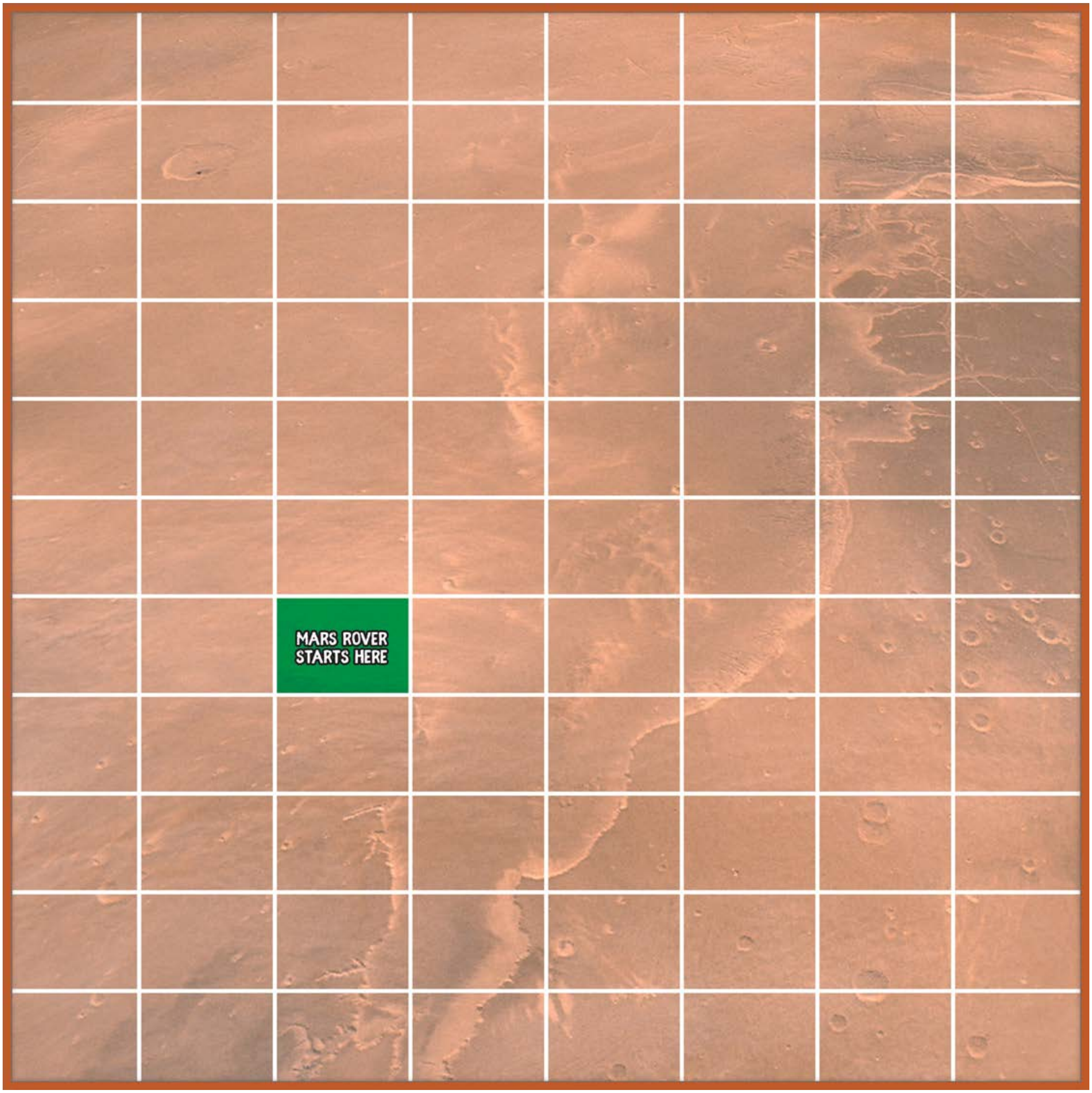


PARTICIPANT HANDOUT 2

INSTRUCTIONS FOR OPERATORS

1. Cut out rover image and put it on the starting square. The arrow on the rover indicates the direction it is facing to move forwards.
2. Face away from the navigation team.
3. Be sure to keep your sense of direction as you navigate the Mars terrain.
4. Each navigation teammate will give you a simple set of instructions.
5. You may ask questions for clarification, but there **must be a time delay of 10 seconds** before a teammate can respond.
6. If a teammate tells you to retrieve a sample within a square, mark "X" to indicate retrieval.
7. To be successful, you must retrieve all lost samples and safely return the rover to the Mars base.

MAP FOR OPERATORS



MATT ROVER IMAGE

Cut out image along dotted lines and use the rover to navigate through the map.

APPENDIX
EXPLANATION OF SAMPLES AND DANGER SQUARES

ICE

Finding water on Mars is exciting. On Earth, whether water is boiling hot or frozen, some living things can thrive. In fact, all living things on Earth are known to require water to survive, even if some only require its presence occasionally. The water on Mars could point to evidence of tiny life forms such as bacteria living on Mars billions of years ago. Scientists are studying the Martian climate such as the annual increase and decrease in size of the polar ice caps and dust storms.

Orbiting spacecraft, landers and robotic rovers have discovered evidence which indicates that Mars had a thicker atmosphere, had more water, and was warmer in the past (billions of years ago). Mars has ancient river valley networks, deltas and lakebeds, as well as rocks and minerals on the surface that could only have formed in the presence of liquid water. Some features suggest that Mars experienced huge floods about 3.5 billion years ago.

There is water on Mars today, but the Martian atmosphere is too thin for liquid water to exist for long on the surface. Today, water on Mars is found in the form of water-ice just under the surface in the polar regions as well as in briny (salty) water, which is thought to seasonally flow down some hillsides and crater walls.

BORON

The presence of boron on Mars indicates that the temperature and pH where it is found was once suitable for habitable life (i.e. a neutral to alkaline pH and temperature between 0 and 60 degrees Celsius).

Boron has been measured in mineral veins in bedrock on Mars. For example, it was observed using the Chemistry and Camera (ChemCam) instrument on NASA's Curiosity Rover in Gale Crater.

FOSSIL

On Earth, fossils in sedimentary rock display a record of past life. Only certain environments and types of deposits provide good fossil preservation on Earth, so on Mars, searches are underway to locate lakes or streams that may have left behind similar deposits.

MAGNETIC ROCKS

Mars has no global magnetic field today, but areas of the Martian crust in the southern hemisphere are highly magnetized, indicating traces of a magnetic field. Magnetic fields shield harmful cosmic radiation. Because Mars contains areas of magnetic materials, this indicates that Mars once had a magnetic field, which has important implications for the prospects for finding evidence of past life on the Martian surface. Studying the ancient magnetic field provides important information about Mars's past interior structure, temperature, and composition. One way that this ancient magnetic field can be studied is by studying Martian rocks which have clung on to the induced magnetization caused by the previous magnetic field.

ANCIENT HOT SPRING

On Earth, hot springs are known to be areas containing a variety of biological organisms. The deposits near ancient Martian hot springs could contain evidence of life from the time the hot springs were still flowing.

The Eridania basin of southern Mars is believed to have held a sea about 3.7 billion years ago, with seafloor deposits likely resulting from underwater hydrothermal activity. Observations by the Mars Reconnaissance Orbiter's (MRO) Compact Reconnaissance Spectrometer for Mars (CRISM) provided the data for identifying minerals in massive deposits within Mars's Eridania basin. The mix of minerals identified from the spectrometer data, including serpentine, talc and carbonate, and the shape and texture of the thick bedrock layers, led to identifying possible seafloor hydrothermal deposits.

This is a significant finding because if Mars had seafloor hydrothermal deposits, life could have existed here, even without a thick atmosphere. On Earth, the earliest evidence of life comes from seafloor deposits of similar origin and age to Mars, so studying Mars's hydrothermal deposits can help us better understand the geology of early-Earth environments.

RADIATION POCKET

Due to its lack of a magnetic field and atmosphere, the surface of Mars is exposed to much higher levels of radiation than Earth. This square is exposed to a particularly high concentration of radiation that is more than MATT is designed to withstand, and would cause the electronics onboard MATT to fail completely.

DEEP CRATER

The largest crater on is the Hellas Planitia and is about 2,300 km in diameter and about 9 km deep. MATT cannot climb out of a crater once it falls inside, so MATT will be stuck.

ANCIENT VOLCANOES

The largest volcano on Mars is Olympus Mons, reaching an elevation of 21,171 metres. MATT is unable to climb over the volcanoes and must navigate around them.