Principles of Remote Exploration (PREP) for Mars

Mars Rover Sample Analysis Mission

Teacher Guide

The Activity: PREP for Mars
The goal of this activity is to deploy a remotely operated rover to analyze a sample of remote terrain from the planet Mars. This activity can be implemented as a competition among teams. It is recommended that there be no more than 6 students per team.

Time Required: Two 50-minute class periods for the rover planning and mission plus any time for supplemental activities.
Activity 1: Arizona Calibration of the Rover (50minutes)
During this activity, students will calibrate their rovers and conduct a test mission on simulated dessert terrain to mimic the surface of Mars.
Activity 2: Mars Sample Return (50minutes)
During this activity, students will map the simulated surface of Mars and compete to see which team will be the first to collect a sample of terrain with their rover.

Educational Standards: see attachment

Related Assessments: see attachment

Student Teams:
Team members should be assigned the following roles:

1. Rover (ROV)-1 student or adult volunteer. The rover will be blindfolded. Navigates the terrain while blindfolded to collect the sample.
2. Mapping (MAP)-1 or 2 students. Produces scale maps of the terrain using graph paper, first *Arizona* then Mars.
3. Communication (COM)-2 students. Develops the communications strategy and delivers the commands to the rover.
4. Calibration (CAL)- 1 or 2 students. Works with ROV to calibrate movements during *Arizona* phase. Monitors the rover's progress, reporting to MAP to update the rover's position on the map.
    - All students, including the rover, should be involved in the mapping phase of the Arizona mission. During both phases, all students work together to plot the rover's course on the map, and all except the rover work together to determine which commands to send the rover.

Activity 1: Arizona Calibration of the Rover

Instructional Objectives:
Students will be able to:

1. Produce a scale map of and environment.
2. Organize, interpret, and use relevant information to devise an effective strategy for communicating with the rover.
3. Describe a mathematical relationship between the commands given to the rover and the response of the rover through measurement of time and distance.

Behavioral Objectives:
Students will:

1. Develop collaborative team skills.
2. Identify alternative ways to find a solution if/when the original plan fails.

Student Materials

- Large graph paper, for mapping land sites (1 per team)
- Ruler or meter stick, for measuring step size (2 per team)
- Stop watch or watch with seconds displayed, for timing rover
- Index cards to write commands on (1 pack per team)
- Team Member Roles worksheets (1 set per team)
- Team Rubric (to be used as self assessment tool)

Teacher Materials

- Tape for making special calibration markers on floor (if there are no floor tiles)
- Classroom, or other area set up with chairs, tables, etc. as obstacles

Student Preparation:
It is important that students have some prior knowledge of graphing, measuring, and coordinate systems.

Teacher Preparation:
Find a designated area for students to practice with their rovers. This could be a classroom, gym, cafeteria, etc. Set up the sample terrain with obstacles (chairs, tables, etc.) for the rovers to maneuver around. Teams can practice on the same terrain or in different corners of the room. Provide spatial calibration markers (e.g. floor tiles or pieces of tape on the floor) so that the students can draw the terrain on graph paper and calibrate the movements of their rovers. Make copies of student worksheets, and gather materials for each team.

Pre-Assessment (optional) (will assess student knowledge of scaling, measurement, graphing, and linear relationships)

Introducing the Activity:
Group students into teams of 4 to 6.

Prompt for students:
You are a team of NASA scientists. Your mission is to deploy a remotely operated rover to retrieve a sample of terrain from the planet Mars. You will be competing against other teams to be the first to successfully analyze the sample. Your final testing phase will be carried out in the dessert. This Arizona phase has four objectives: mapping, communication, calibration, and testing. First the terrain must be mapped using remote sensing. Next the rover must be calibrated and the communications team must practice sending commands to the rover. Finally you will conduct a test run of your rover.

Hand out the Team Member Roles worksheets to students (These will be in the student materials, and should contain info about what each member does, maybe with a picture. Followed by the directions for each activity. Possibly with Arizona on front and Mars on back.) Allow students to read over materials and select roles within teams. If available, an adult volunteer or student aid may play the role of the rover.

Mapping the Terrain (10 minutes)

Once the students have decided on their roles, lead them to the Arizona terrain. They should first draw a scale map of the terrain using graph paper. The MAP team member(s) should draw the actual map, and should lead other members in the measuring and scaling of the terrain. The spatial calibration marks or floor tiles will enable students to calibrate their maps. The students can be told, or can measure, the actual distance of the marks or tiles. Show the students the "landing site" and "sample site" in the Arizona terrain. The students should include these locations on their map.

Calibrating and Communicating with the Rover (10-20 minutes)

These two phases should happen at the same time, CAL working with MAP, and COM working with ROV.

- COM works with ROV to determine how many commands the rover can reliably execute in each command sequence. The command sequence must be given in the manner provided. COM should keep a log of the commands given to rover, and times taken to execute the commands.
- CAL measures the rover's movements as COM delivers commands. CAL should keep a log of their measurements, and the time taken to execute the commands. MAP uses these measurements to calibrate rover's movements with the map scale.

Arizona Test Run (10-20 minutes)

In this final testing phase, the teams will plan a route for the rover to navigate from the "landing site" to the "sample", following the directions provided on the *student worksheet*. The teams should pick a place to stand outside of the terrain but close enough so they can see the rover.

Things to keep an eye out for…

- Students trying to measure more precisely than necessary. NASA missions are always limited by time. The students should be careful not to measure so meticulously that they run out of time before a basic map is produced.
- It takes some students a while to understand that all actions taken by the rover must be dictated by the commands.
- Rovers that might tend to try to execute the commands before repeating the command sequence back to COM.
- The goal is to find the optimal length for the command sequence. Short sequences will cost the team time, just as long sequences cost the team time if the rover makes mistakes and shuts down. Remember maneuvering around object is time consuming as well.
- There is a potential for non-linearity of rover's movements, particularly for a large number of steps.

Discussion Questions: (10 minutes)

After the test run, students should discuss the following questions, either as a whole class or within teams.

1. Does the rover get better at remembering commands with practice?
2. Does the rover remember some commands or command sequences better than others?
3. What is a reliable number of commands to use to ensure that the rover won't make a mistake?
4. Is the shortest distance always the fastest route?
5. What features of a map make it easier to use?
6. What is the hardest part of getting the rover to go where you want it to go?
7. What important reminders should be written down to make sure the run on Mars goes smoothly?