

Unit 2: Challenge - Olympus Mons Mineral Challenge**Objectives:**

In this culminating Challenge for Unit 2, you will use the student map to plot a path around Olympus Mons that finds and identifies all the minerals. Coordinate points (x,y) are used to write a program on a calculator connected to TI-Innovator™ Rover. Students will use the color sensor and If-then statements to find and identify various minerals based on color. Finally, students will test their paths and programs on the drive mat that the teacher has laid out on the floor of the classroom.

Students will:

1. Use the color sensor and a While loop to detect colors on the Olympus Mons map
2. Use an If Then statement to display messages based on detected colors.
3. Plot a course on the student map using **X,Y** coordinates to navigate around Olympus Mons.
4. Test and refine their program by driving a TI-Innovator™ Rover on the Olympus Mons drive mat.

Background:

One of the main goals for the Mars Exploration Rovers© is to perform geological tests on soils and rocks to determine clues to the planet's past. The initial goal for the rover was to drive and analyze about 40 yards of terrain each day. The Mars Exploration Rovers© contain a camera and high resolution imagers for imaging; different types of spectrometer's to analyze temperature, mineralogy and elemental make up; and magnets to collect magnetic dust particles. For more information about the Mars Exploration Rovers© go to <https://mars.nasa.gov/mer/overview/>.

In this challenge, students will aim to identify four minerals:

- Olivine is typically green in color. As a gem it is called "peridot" and serves as the birthstone for August.
- Azurite is a rare blue mineral that often indicates the presence of copper deposits. It can be ground to make pigments or polished for jewelry.
- Sulfur is a bright yellow chemical element. Sulfur is a key element in the production of matches, insecticides and fertilizers.
- Calcium Carbonate is white chemical compound. Calcium Carbonate is a key ingredient in antacids.

TI-Innovator Rover™ Set-up

- Tape down the edges of the Olympus Mons drive mat to the floor (the mat is about 1 square meter). * Note that having more than one map is ideal, so multiple students can group can “drive” at one time. An alternative, it to first have students use the smaller map on the student activity sheet to plan their initial program, then make adjustments as needed when it is their turn to drive on the larger map.
- “Minerals” are represented by the construction paper squares, which should be centered above the colored x’s toward the edge of the Olympus Mons drive mat. For example, notice the blue construction paper placed above one of the x’s on the maps below**.
- If printing the drive mat is not possible, set up a 10 cm grid on a piece of 3’ x 3’ (or larger) butcher paper. For example, a coordinate of (3.5, -0.5) would be located 35 cm in the X direction and 5 cm in the –Y direction (see image for reference).
- Because construction paper can vary in color (black may appear as gray or vice versa), you should use the following program (given in teacher notes below) to test your colors using the color sensor on the rover.
- To do this, run the coLoRTEST.8xp program. Students will pick up and move the rover from each of the colors of construction paper that they plan to use, being sure to place the color sensor above the paper. The color test program will report the color rover sees.
- Before students do this challenge, make sure they are aware of the color for each of the construction paper squares. Recall that each color has an associated number (1-red, 2-green, 3-blue, 4-cyan, 5-magenta, 6-yellow, 7-black, 8-white, 9-gray.).

Color Test Code:

```
PROGRAM: CLRTEST
Send ("CONNECT RV")
0→C
0→K
While K≠45
  Send ("READ RV.COLORINPUT")
  Get (C)
  Disp "COLOR NUMBER=", C
  Wait 0.5
  getKey→K
End
```

Materials:

- *laminated Olympus Mons drive mat
- meter stick
- ruler
- masking tape
- colored construction paper
- student map of Olympus Mons

Student Activity:

Challenge 1: Use the Olympus Mons drive mat and plot a course around the volcano that drives over the squares of colored construction paper (representing minerals) attached to the mat. When the Rover drives over the following colors, display an appropriate message on the calculator such as:

- If green (2), display "Olivine Found!"
- If blue (3), display "Azurite Found!"
- If yellow (6), display "Sulfur Found!"
- If white (8), display "Calcium Carbonate Found!"

Teacher Notes:
Teacher Guidance during Challenge 1:

- This challenge requires students to use the "RV to XY" command to drive a path around the Olympus Mons volcano. Simultaneously, students will use the COLRINPUT sensor to read and report minerals found on the surface of the path. To determine the (x,y) points required for the code, students can either determine the points from the large drive mat itself or use the smaller copy located on the student handout first, and then make adjustments as necessary when driving the larger map.
- Reading the RV.WAYPOINT.CMDNUM is used to determine if the Rover has completed driving its path. The CMDNUM value will be 0 if the Rover is still driving its path and 1 if the Rover has completed the path. In the program the While loop that reads the COLORINPUT sensor checks to determine if the Rover is still driving the path with the conditional statement $N=0$. The program will run the While loop when $N=0$ is true. The program will exit the While loop when the Rover is finished with its path and the CMDNUM value is 1, which means that $N=0$ is false.
- Note: Find "READ RV.WAYPOINT.CMDNUM" on the Rover Read RV Path menu found at Menu/8: Hub/7: Rover (RV)/4: Read RV Path/3: RV.WAYPOINT.CMDNUM
- The initial value of 0 for N ensures the loop will run at least once.
- The program uses If..Then commands to match color values with minerals.
- Please see the associated sample program, U2C2CHAL.8xp as a reference if help is needed

```
PROGRAM: C2CHAL
Send("CONNECT RV")
Send("RV TO XY 3.5 -0.5")
Send("RV TO XY 5.5 2.5")
Send("RV TO XY 5 6")
Send("RV TO XY 2 6.5")
Send("RV TO XY -1.5 5.5")
Send("RV TO XY -1.5 2")
Send("RV TO XY 0 0")
ClrHome
0→N
While N=0
  Send("READ RV.WAYPOINT.CMDNUM")
  Get(N)
  Send("READ RV.COLORINPUT")
```

```
Get(C)
Output(2,1,"COLOR NUMBER= ")
Output(2,15,C)
If C=2
Then
  Output(4,1,"OLIVINE FOUND")
End
If C=3
Then
  Output(5,1,"AZURITE FOUND")
End
If C=6
Then
  Output(6,1,"SULPHUR FOUND")
End
If C=8
Then
  Output(7,1,"CALCIUM CARBONATE FOUND")
End
End
```

- **Extension:**

Have students collect data at each turning point. After running the program, students can plot the points on a Data and Statistics page. The scatterplot will match the points on the Olympus Mons drive mat. The code to collect the data is given below. It should go at the end of the basic program.

Sample Code:

```
0→A
While A = 0
Send "Read RV.WAYPOINT.CMDNUM"
Get(A)
Wait 0.2
End

Send("Read RV.PATHLIST.X")
Get (L1)

Send("READ RV.PATHLIST.Y")
Get (L2)
```

Challenge 2: Change the LED light to match the color of the last mineral found and play a specific sound for each mineral when it is found.

Teacher Guidance during Challenge 2:

- Please see the associated sample program, U2C2CHAL2.8xp as a reference if help is needed

Sample Code:

```
PROGRAM:C2CHA2
Send("CONNECT RV")
Send("RV TO XY 3.5 -0.5")
Send("RV TO XY 5.5 2.5")
Send("RV TO XY 5 6")
Send("RV TO XY 2 6.5")
Send("RV TO XY -1.5 5.5")
Send("RV TO XY -1.5 2")
Send("RV TO XY 0 0")
ClrHome
```

```
0→N
While N=0
  Send("READ RV.WAYPOINT.CMDNUM")
  Get(N)
  Send("READ RV.COLORINPUT")
  Get(C)
  Output(2,1,"COLOR NUMBER= ")
  Output(2,15,C)
  If C=2
  Then
    Output(4,1,"OLIVINE FOUND")
    Send("SET COLOR 0 128 0")
    Send("SET SOUND 260")
  End
  If C=3
  Then
    Output(5,1,"AZURITE FOUND")
    Send("SET COLOR.BLUE")
    Send("SET SOUND 300")
  End
  If C=6
  Then
    Output(6,1,"SULPHUR FOUND")
    Send("SET COLOR 255 255 0")
    Send("SET SOUND 340")
  End
  If C=8
  Then
    Output(7,1,"CALCIUM CARBONATE FOUND")
    Send("SET COLOR 255 255 255")
    Send("SET SOUND 380")
  End
End
```

****SET-UP:** Map printed looks like this:

Teacher will add colored paper over the X's on the map, to look like this:

