

Unit 1: Challenge - Driving Around Olympus Mons
Objectives:

Students will use the student map to plot the shortest path around Olympus Mons. The scaled values and angles are used to write a program on a calculator connected to TI-Innovator™ Rover. Students test their paths and programs on the drive mat that you set up on the floor of the classroom.

Students will:

1. plot a course on the student map using a ruler and protractor to navigate around Olympus Mons.
2. use proportional reasoning to convert student map distances into scaled drive distances.
3. use their scaled map measurements to write a TI-BASIC program on their calculator.
4. test and refine their program by driving a TI-Innovator™ Rover on the Olympus Mons drive mat.

Background:

Orienteering is a navigation skill that uses several tools to identify the shortest path from one point to another, often while avoiding obstacles in the terrain. Some of these orienteering tools include a terrain map, protractor, and ruler. Most maps have a scale and compass rose printed in the corner. The scale is a proportion factor that converts a distance measured on the map to the distance in the actual terrain. Similarly, the compass rose is a diagram on the map that indicates the true north direction in the actual terrain. A skilled person with a scaled map and proper tools can lay a course on that map and use it to navigate the course on the terrain. In this activity, the drive mat represents the “actual terrain” while the student map is the “scaled map”.

TI-Innovator™ Rover Set-Up:
Materials:

Students may work in groups of two or three. Choose an area to work that has at least 2 meters of clear uniform floor space. Carpeted flooring is less desirable than tile. If needed, driving mats may be used as a driving surface.

Tape down the edges of the Olympus Mons drive mat to the floor (the mat is about 1 square meter) and construct the map:

- Place obstacles on the inside of black “X” marks around the perimeter of the volcano.
 - Students should consider the width of the rover when determining their path to avoid obstacles.

***You may notice colored “X” marks on the drive mat. These will be used in a later challenge in Unit 2.*

- TI-Innovator™ Rover
- laminated Olympus Mons drive mat
- Student map of Olympus Mons (in student handout)
- meter stick
- ruler
- protractor
- masking tape
- Obstacles such as miniature traffic cones, Styrofoam blocks, rocks, etc.

Prerequisites:

- Although It is recommended that the “On Ramp to Robotics” activities are done in sequence, starting with Unit 1 – Skill Builder 1, this “Challenge: Drive Around Olympus Mons” can be done as a stand-alone activity if students have some background with coding and Rover already, or you provide a “crash course” on how to drive Rover.
- If students are new to programming, it is strongly recommended that they visit *10 Minutes of Code for the TI-Innovator Hub* for an introduction to programming in TI-BASIC at www.education.ti.com/en/activities/ti-codes
- Students should have a general understanding of the TI-BASIC editor and how to run a program, and the following skills:
 - Basic navigation on the calculator.
 - Saving and opening files.
 - Editing new and existing programs.
 - Running programs.
 - Editing program features.
 - See example program c1 in [U1SB1 Example Programs.tns](#)

Student Activity:

Teacher Notes:

1. Find the *scale* of the student map.
 - Measure the width of the Olympus Mons drive mat in the unit of meters and record the value in the table below.
 - Measure the width of the Olympus Mons student map in the unit of centimeters and record the value in the table below.

- Be sure students measure in units of *meters* on the drive mat and *centimeters* on the student map.
- Be sure students calculate with meters in the numerator and centimeters in the denominator.
- *Note* that the “Student Map” is provided as part of the student handout. This is a scaled down version of the larger laminated “drive” map.

Calculate the scale of the student map using the formula below.

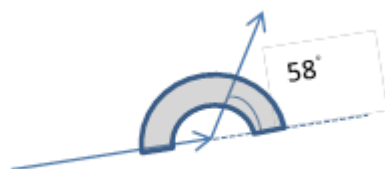
2. Design a path around the volcano that avoids the marked obstacles. Use a ruler and pencil to draw that path of line segments onto the student map.
3. Use a protractor to measure the exterior angles that are needed for Rover to turn from one line segment to the next along your path. You may find it helpful to extend the path line beyond the turning point to aid in measuring the exterior angle
4. Measure each path segment in cm and record in the table; use the map scale to calculate the distance the Rover must drive on the Olympus Mons drive mat.

Teacher Notes:

Add various obstacles such as miniature traffic cones, styrofoam blocks, rocks, etc.to the map.

Teacher Notes:

Example exterior angle measurement:



Teacher Notes:

Example calculation: a drive segment may be 6 centimeters and the student map scale may be 0.04m = 1 cm (this is an example only. Students must find the actual scale using their own calculations and measurements), find the drive distance in meters:

$$6cm \times \frac{0.04m}{1cm} = 0.24$$

5. Write a TI-Innovator Rover program that drives each segment in path.

Example:

Send "RV FORWARD 0.24 M"
Send "RV LEFT 58"

Teacher Notes:

Send "CONNECT RV"

Send "RV RIGHT 11"

Send "RV FORWARD .255 M"

Send "RV LEFT 38"

Send "RV FORWARD .297 M"

Send "RV LEFT 67"

Send "RV FORWARD .488 M"

```
Send "RV LEFT 78"
Send "RV FORWARD .438 M"
```

```
Send "RV LEFT 58"
Send "RV FORWARD .286 M"
Send "RV LEFT 58.5"
Send "RV FORWARD .426 M"
```

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 program.

```
While cmdnum=0
  Send "READ RV.WAYPOINT.CMDNUM"
  Get cmdnum
  Wait 0.1
EndWhile
DispAt 8,"Rover is Finished! "
Send "READ RV.PATHLIST.X"
Get x_path
Send "READ RV.PATHLIST.Y"
Get y_path
```

```
Send "CONNECT RV"
Send "RV RIGHT 11"
Send "RV FORWARD .255 M"
```

```
Send "RV LEFT 38"
Send "RV FORWARD .297 M"
```

```
Send "RV LEFT 67"
Send "RV FORWARD .488 M"
Send "RV LEFT 78"
Send "RV FORWARD .438 M"
```

```
Send "RV LEFT 58"
Send "RV FORWARD .286 M"
```

```
Send "RV LEFT 58.5"
Send "RV FORWARD .426 M"
```

```
c:=0
While c = 0
```

Send “Read RV.WAYPOINT.CMDNUM”

Get c

Wait 0.2

EndWhile

Send “Read RV.PATHLIST.X”

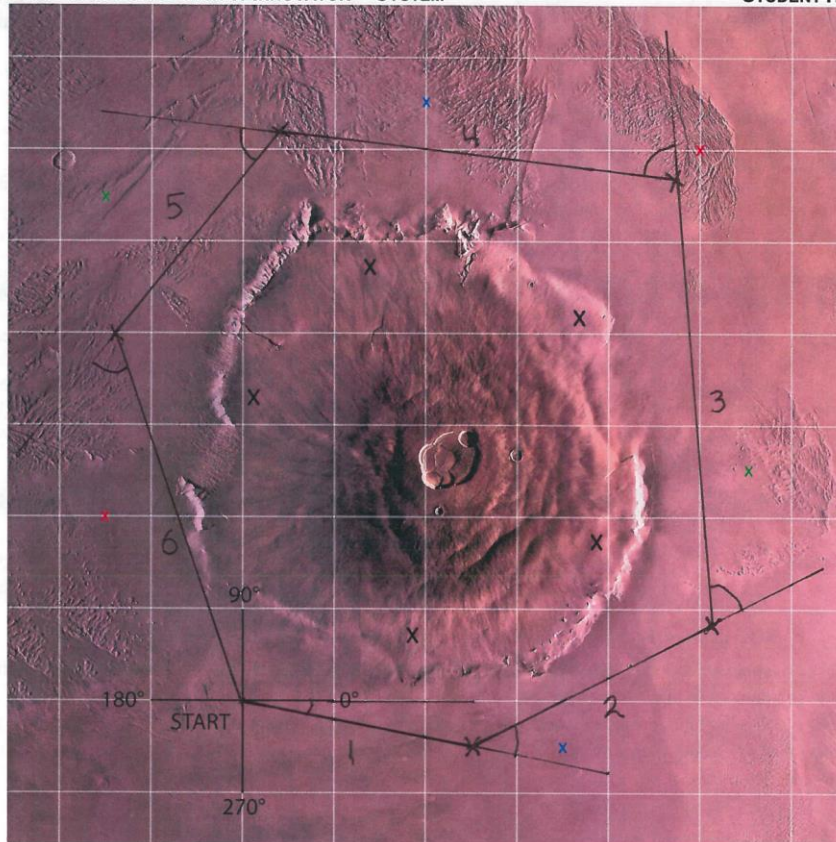
Get x_path

Send “READ RV.PATHLIST.Y”

Get y_path

THE ON-RAMP TO ROBOTICS WITH TI-INNOVATOR™ SYSTEM

STUDENT HANDOUT



Drive Mat width: .914 meters (m)
 Student Map width: 16.3 centimeters (cm)
 Scale (Drive Mat Width ÷ Student Map Width): .0561 meters/centimeter

Segment	Angle (degrees)	Turn Direction (L/R)	Student Map Length (cm)	Scaled Drive Mat Length (m)
1	11.0	R	4.55	.255
2	38.0	L	5.30	.297
3	67.0	L	8.70	.488
4	78.0	L	7.80	.438
5	58.0	L	5.10	.286
6	58.5	L	7.60	.426