BUILDING A ROVER
Teaching Guidelines

Subject: Mathematics

Topics: Algebra—Coordinate Systems, Patterns, Relations and Functions; Linear Functions

Grades: 6 – 12

Knowledge and Skills:

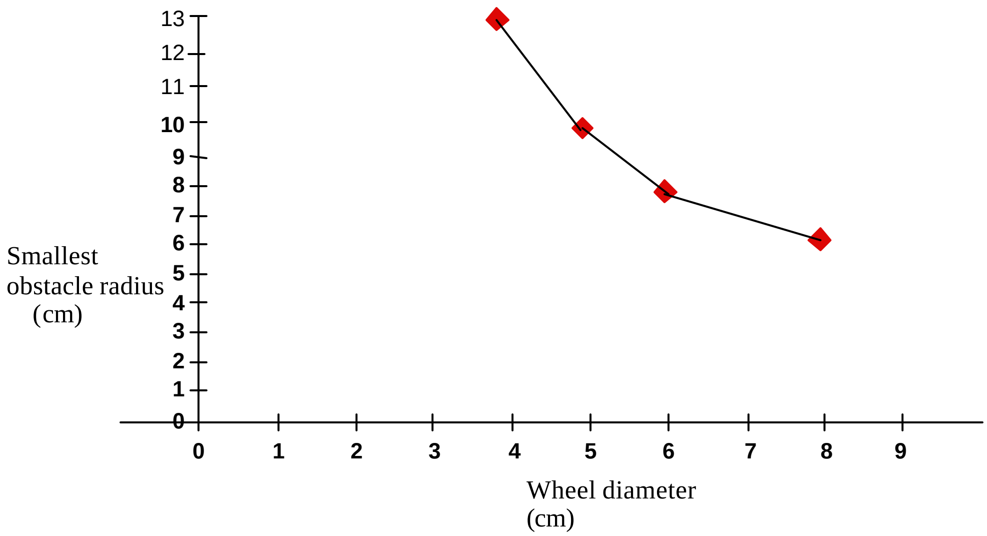
- Can plot a point in a two-dimensional coordinate system, given the coordinates, or determine the coordinates of a given point
- Can extrapolate a graph when a pattern exists
- Can relate aspects of a graphical model to the real world situation which is being modeled
- Understands that linear functions are characterized by the fact that the ratio of change in independent variable to change in dependent variable is constant

Answers:

1–3.

Test	Wheelbase (cm)	Wheel diameter (cm)	Radius of smallest obstacle that the rover can climb over (cm)
1	15	6	*7.9*
2	15	7	*6.3*
3	15	5	*10.0*

4.



5. The exact answer to question 5 is 13.1 cm. Student answers will vary somewhat. One approach that students might take is to draw a straight line that comes closest to all three points. Use this question as an opportunity to discuss the fact that the three points in fact do not lie on one line, and this can be demonstrated by the fact that the slope of a line between the two of the points is not equal to the slope of the line between any other two of the points.

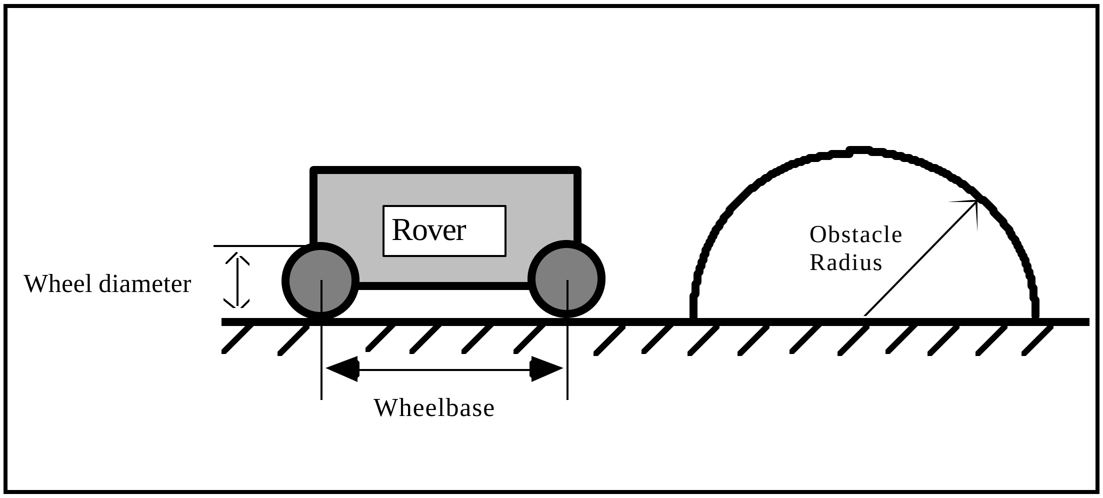
6. The claim is true because the bottom of the vehicle is high enough to clear any obstacle that fits between the wheels.

7. Students should notice that the larger the radius of the obstacle, the easier it is for the rover to travel over it. In addition, students might note that rovers with relatively large-diameter wheels can successfully deal with a wider range of obstacle sizes.

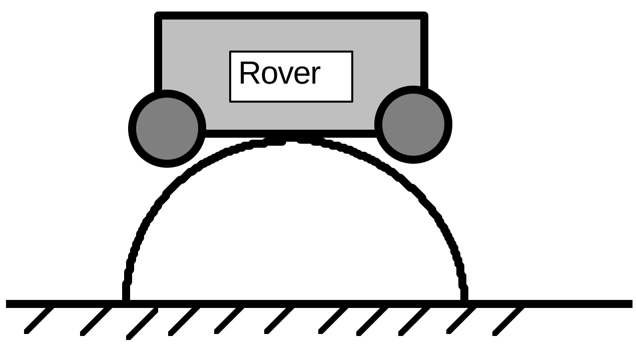
8. The students should determine that the longer the wheelbase, the more likely the rover will get stuck.

Building a Rover

This diagram shows a 4-wheeled rover approaching a simple curved obstacle.



In this case, the rover would get stuck trying to get over the obstacle:



In this project, you will investigate how a rover could best be designed so as to avoid getting stuck.

1. Using large index cards (or manila folders) and tape, make a flat model of a rover. The wheels should be 6 centimeters in diameter and the wheelbase 15 centimeters. Use a rectangle that is 15 centimeters long to represent the body of the rover. Cut two circles to represent the wheels. Tape them onto the body so that the centers of the wheels are at the corners of the rectangle.

2. On a sheet of paper, draw a semicircle with a radius of 5 centimeters. The semicircle will be the obstacle for your model. See if your rover can climb over the obstacle without "getting stuck"— that is, having its bottom touch the obstacle.

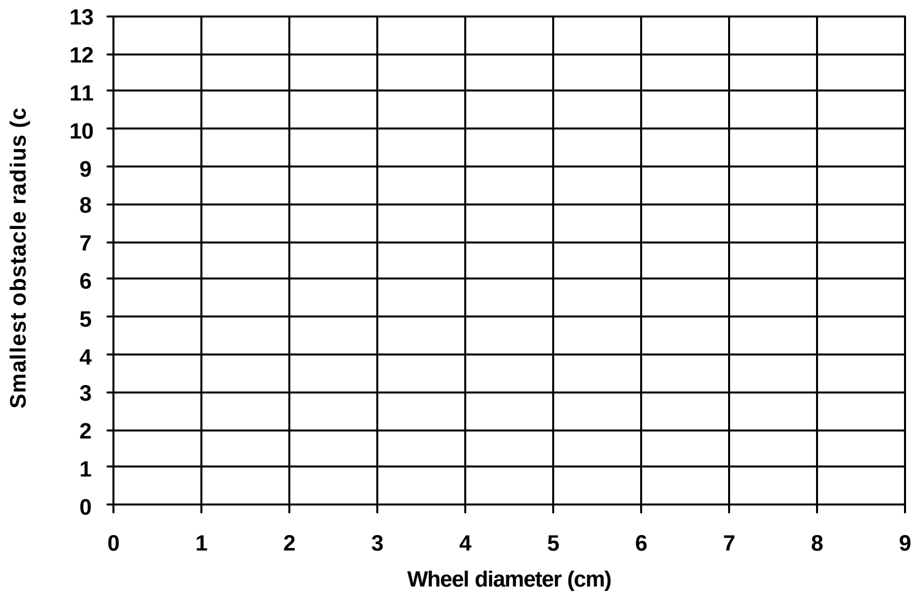
3. If the rover gets stuck on the 5-centimeter obstacle, draw an obstacle with a radius of 10 centimeters and repeat the test. Try a series of obstacles of different sizes until you find the smallest obstacle that the rover can climb over. (Each radius must be greater than 5 centimeters but less than 10 centimeters.) Use this table to record your results.

Test	Wheelbase (cm)	Wheel diameter (cm)	Radius of smallest obstacle the rover can climb over (cm)
1	15	6	
2	15	7	
3	15	5	

4. Suppose we make the wheels larger while leaving the wheelbase unchanged at 15 centimeters. Try wheels that are 7 centimeters in diameter. Again, find the radius of the smallest obstacle that the rover can climb over. Add your results to the table.

5. Suppose we make the wheels smaller. Try a wheel diameter of 5 centimeters and record your results.

6. Use this graph to plot your results.



7. Suppose we wanted to use wheels with a diameter of 4 centimeters. Use your graph to estimate the radius of the smallest obstacle that the rover could climb over.

8. Suppose someone claims to have designed a rover that can climb any size obstacle. The rover has wheels that are 9 centimeters in diameter and a 15-centimeter wheelbase. Please test this claim, and if it is true, offer an explanation.

9. Optional: Investigate what happens when we change the wheelbase instead of the wheels. For example, try a rover with wheels that are 7 centimeters in diameter. Make the wheelbase 14 centimeters long, then 13 centimeters long, and so on.