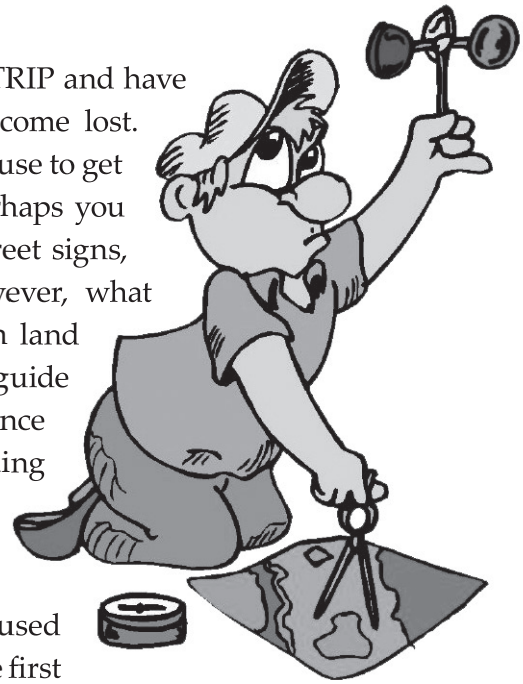
Learning Cycle Two

Plotting the Course

2

Introduction



MOST OF US HAVE BEEN ON A TRIP and have taken a wrong turn, only to become lost. What tools or techniques did you use to get yourself back on the correct path? Perhaps you used a map. Maybe you looked for street signs, landmarks, or used a compass. However, what if you found yourself lost in a foreign land without maps or street signs to help guide you? How would you determine distance and direction, so you could avoid walking around in circles?

During this learning cycle, you will be exploring how simple systems can be used to monitor distance and direction. In the first *Exploration* activity, you will be determining distance using mathematic equations. In the second activity, you will be measuring distance by constructing a transit. After completing this learning cycle, you will apply what you have learned about distance and direction to your *Primary Challenge* solution.

Objectives

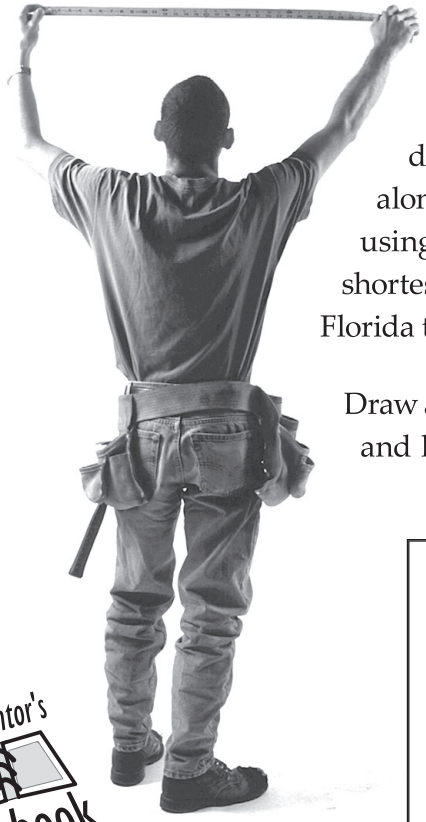
After completing this learning cycle, you will be able to:

1. Determine distance using the Phythagorean Theorem (geometry).
2. Determine distance using a transit.

How has the ability to navigate by knowing distance and direction changed the way we travel?

Exploration 1

Determining Distance Using Mathematics



The distance for an airplane to travel from Miami, Florida to Tallahassee, Florida is approximately 400 miles. Let's assume that you must make this trip but you do not have enough money to fly and must take your car along a fixed route of travel. During this activity, you will be using the map in Figure 1 and a calculator to determine the shortest route between your departure location in southern Florida to your destination location in northern Florida.

Draw a right triangle in the Inventor's Logbook space provided and label the adjacent, opposite, and hypotenuse sides.

Inventor's Logbook

Logbook 2.1

Using the Pythagorean Theorem and other trigonometry relationships, determine which route is the longest, according to the map in Figure 1. Record your data for each route in Table 1.

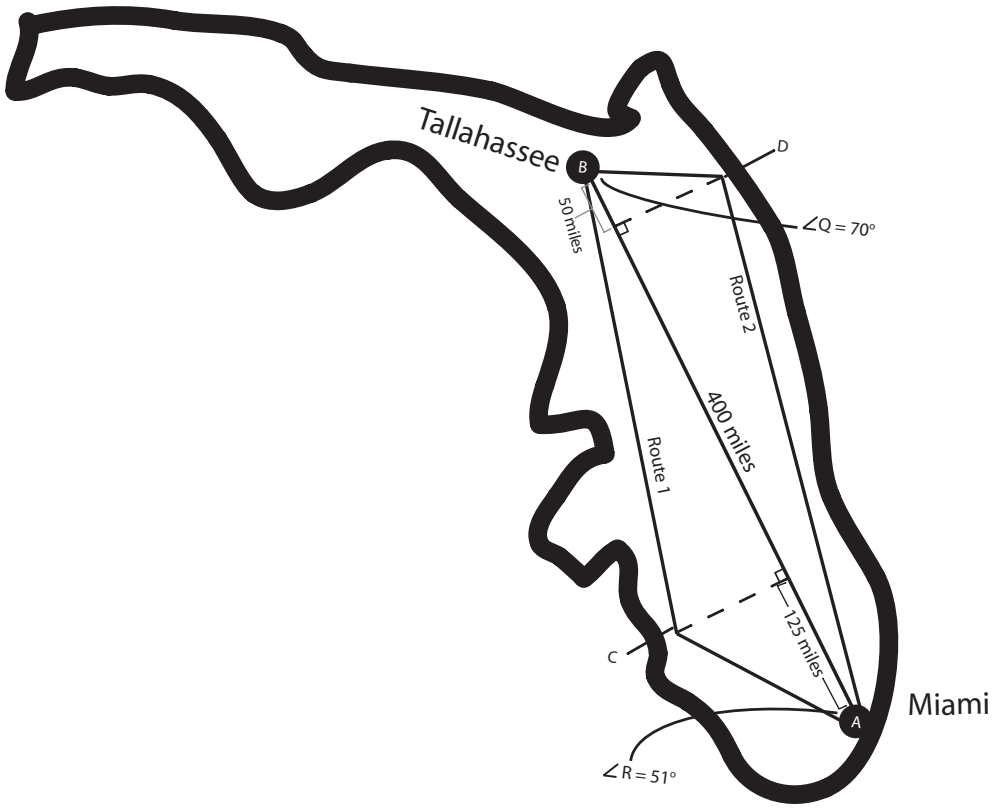


Figure 1.

Inventor's Logbook

Logbook 2.2

Table 1.
Distances for Route One and Route Two

Route	Length of Line Segments (miles)				Degree for Angle Q	Degree for Angle R	Total Distance Traveled
	A, C	C, B	A, D	D, B			
1			NA	NA			
2	NA	NA					

Reflection

Inventor's Logbook

Logbook 2.3

Find the answers to the following questions and write them in the Inventor's Logbook spaces provided. Be prepared to discuss your answers with the class.

1. What is the shortest land route from your departure location to your destination location in Florida? How do you know?

_____

_____

_____

2. If the speed limit on Route 1 is 45 m.p.h. and the speed limit on Route 2 is 55 m.p.h., what would be the quickest route to your destination?

_____

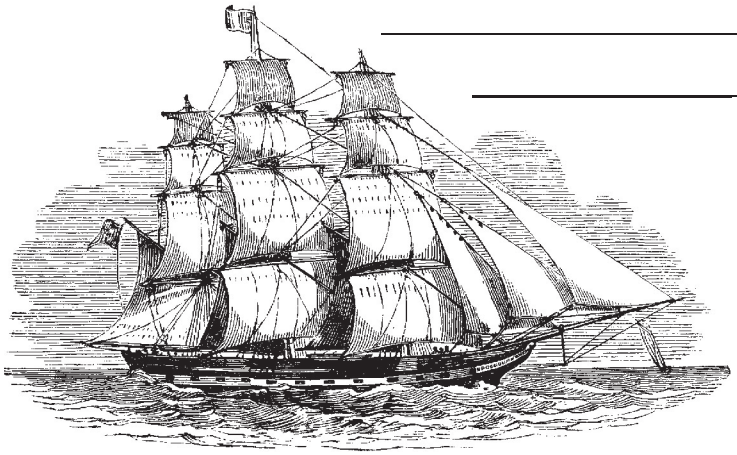
_____

3. What other mathematical tools could be used to calculate the distance for this trip?

_____

_____

_____



Exploration II

Measuring Distance

During this activity, you are going to construct a *transit*, which will be used later to measure angles and calculate distances. You will then use a tape measure and a laser-measuring device to check the accuracy of your calculations.

Your instructor will divide the class into teams to complete the following activity. After your team has completed the activity, record the results and answer the *Reflection* questions in the space provided.

Constructing a Transit

1. Obtain a photocopy of a protractor from your instructor.
2. Using a glue gun, glue this protractor onto a piece of ¼" plywood. The bottom or flat part of the protractor should be about 1" from the edge of the plywood and should run parallel with this edge.
3. Using a band or scroll saw, cut along the curved part of the protractor.
4. Cut a piece of ½" PVC pipe to a length as shown in Figure 1 on the following page.
5. Drill a small hole through the PVC pipe about 1" from one end. The hole should be equal to the diameter of the screw.

Key Terms

Transit:
A surveying instrument, usually constructed of a small telescope mounted on a tripod, that measures horizontal and vertical angles

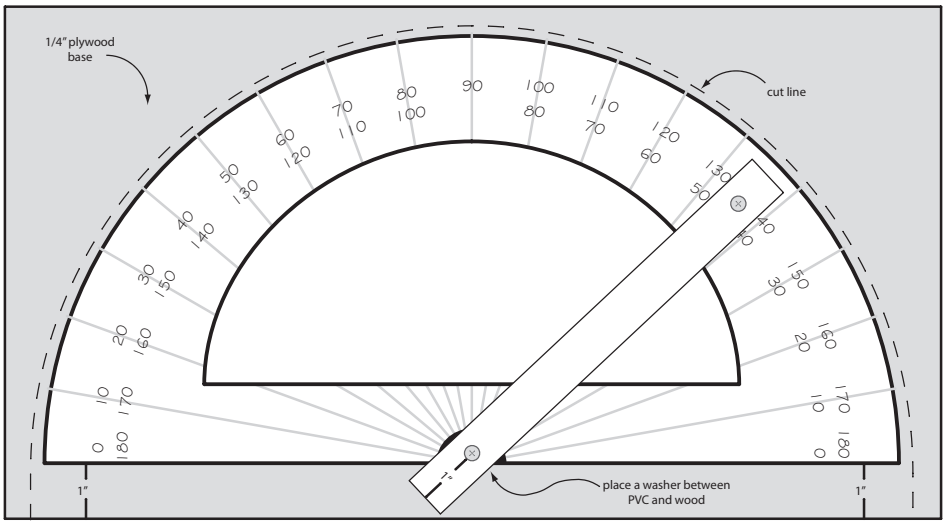


Figure 1. Constructing the transit

6. Attach the pipe to the plywood with a screw at the center point of the protractor. A small washer should be placed between the pipe and the wood. Do not attach too tightly.

7. Drill another smaller hole at the other end of the pipe as shown. This hole must be slightly smaller than the diameter of the screw. The hole should be located so that it is directly above the measure angles on the protractor.

Reflection

Find the answers to the following questions and write them in the Inventor's Logbook spaces provided. Some of these questions may require you to conduct research on the Internet or other available resources. Be prepared to discuss your answers with the class.

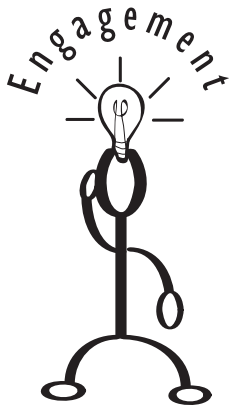
Inventor's Logbook

Logbook 2.4

1. What type of applications would require very accurate, expensive distance-measuring devices? Identify at least one application for each mode of transportation.

2. Knowing the formula (distance = velocity x time), explain how a laser-measuring device uses a light wave to determine distance.

3. Submarines use high-frequency sound waves to calculate distance under water, much like dolphins use high-frequency sounds to communicate. Light waves and sound waves are very similar. With this in mind, how do submarines use high-frequency sound waves to determine distance?



Engagement

You will now have the opportunity to use the transit your team created. Your instructor will assign you a distance to measure. Using your transit, measure and record the distance. The following is an example of a distance your instructor may have you measure.

Inventor's Logbook

Logbook 2.5

A cone has been placed on the goal line near the edge of a football field. Your team must stand on the other goal line and measure the distance.

1. Using a tape measure, measure 100′ towards the 50-yard line.
2. From this point, use the transit to sight the cone. Record the angle below. _____ degrees.
3. Using this angle, calculate the distance from one edge of the field to the cone.

To Check the Accuracy of Your Transit

Inventor's Logbook

Logbook 2.6

1. Use the laser measuring device to measure the distance above.
2. Record the reading: _____ feet
3. Use a tape measure and measure the distance.
4. Record the reading: _____ feet

Inventor's Logbook

Logbook 2.7

Once you have measured the distance and checked the accuracy of your transit, answer the following questions in the Inventor's Logbook space provided. Be prepared to discuss your answers with the class.

1. Calculate the variation between the largest and smallest measurement taken by the three different measuring devices (transit, tape measurer and laser measuring device).

_____

_____

2. Which measurement was more accurate? Why?

_____

_____

3. What differences would you expect to see in the design and construction of a transit used by engineers compared to the one you made? Why?

_____

_____

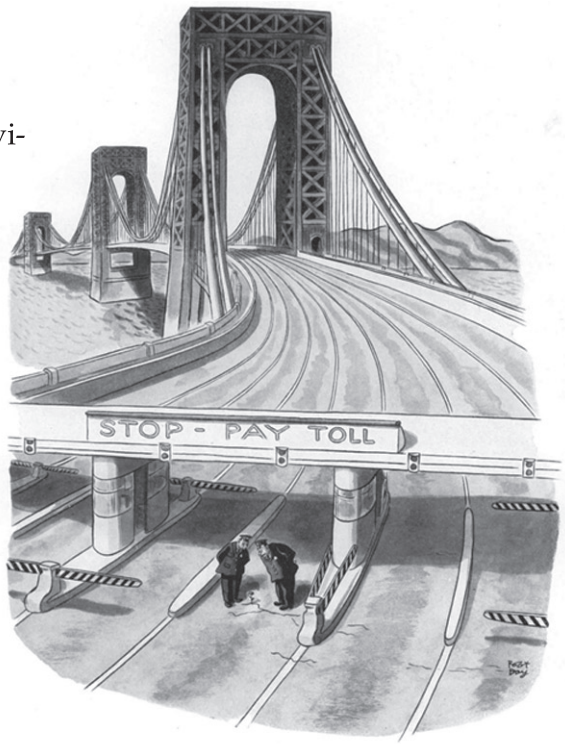
4. If you noticed differences between the teams' measurements, what are some plausible reasons?

_____

_____

Expansion

Select one of the following *Expansion* activities to engage in and follow the directions.



1. If you have traveled along the interstate highway, you have likely had to stop and pay a toll. Have you ever noticed a special lane set aside for cars with an electronic pass? These lanes allow vehicles to go through the tollbooth without stopping. Conduct research to determine how technologies such as this make travel faster, safer, or easier.

2. How did people navigate before global positioning systems or detailed maps were available? Conduct research and discuss historical methods of navigation before these current technologies were developed. Explain how you could use a specific historic method of navigation to get from your school to a nearby city.

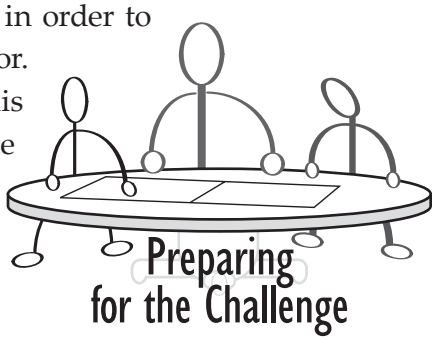
3. Have you ever encountered a person from a different culture who did not speak the same language as you? It can be a rather frustrating experience, especially if you are trying to reach a specific destination. Develop some specific methods for giving directions to another student who does not speak a language with which you are familiar. How would you convey direction? What about roads, bridges, towns, or buildings? Explore the possibilities of non-verbal communication methods.

Career Connections

Cartographer
Flight Engineer
Surveyor
Urban/Regional Planner

Here are some careers related to this learning cycle. For more information, visit the United States Department of Labor's Occupational Outlook Handbook at: www.bls.gov/oco

You will be required to navigate (without deviation from the course) to several destinations and determine the total distance of your path in order to solve the *Primary Challenge.* Accuracy is an important factor. With the knowledge and skills you have gained through this learning cycle, how will your team determine the distance that your vehicle must travel? Your instructor may provide some time for your team to brainstorm some possible solutions to this problem at this time. If not, record some ideas below for how to solve this problem. Discuss these with your team the next time you meet.



Inventor's Logbook

Logbook 2.8

Plotting the Course

Name: Date:

Element	Criteria				Points
	4	3	2	1	
Measuring devices	Demonstrated a complete understanding of the proper use of measuring devices.	Demonstrated a considerable understanding of the proper use of measuring devices.	Demonstrated a basic understanding of the proper use of measuring devices.	Demonstrated limited or no understanding of the proper use of measuring devices.	
Mathematical computation	Demonstrated a complete understanding of the proper mathematical formulas.	Demonstrated a considerable understanding of the proper mathematical formulas.	Demonstrated a basic understanding of the proper mathematical formulas.	Demonstrated limited or no understanding of the mathematical formulas.	
Inventor's Logbook Trade-offs	Fully identifies and comprehends the trade-offs considered while designing.	Identifies and comprehends most trade-offs considered while designing.	Identifies and comprehends some trade-offs considered while designing.	Does not identify or comprehend trade-offs considered while designing.	
				Total Points	