



Land Survey

William Clark did most of the surveying and mapping for the Lewis and Clark Expedition. When he needed to measure the distance between two points that were far apart, he used a method called *triangulation*. In triangulation, surveyors use a long chain, angles, and a mathematical formula to determine distance.

To do a land survey you will need a partner, two protractors, two poles attached with a 10-foot piece of rope, a tape measure and our chart.

1. Pick the two points (A and B) that you would like to measure. You must be able to see clearly between the two points.
2. Stick Pole One on the ground at Point A. Place the center point of Protractor One into the top of Pole One.
3. Place the viewer of the protractor at 0° and adjust the protractor until you can see Point B through the viewer. Without moving the protractor, move the viewer to 90° . Move Pole 2 until the rope lines up with the viewer.
4. Place the center point of Protractor Two into the top of Pole Two. Place the viewer of Protractor Two on 90° and adjust the protractor until the rope can be seen through the viewer.
5. Now you are ready to get your angle. Adjust the viewer on Protractor Two until Point B can be seen in the viewer. Look at the angle on the protractor. Now flip these instructions over and look at the chart. Find your angle or the angle closest to it. How far apart are Point A and Point B? Check your answer using the measuring tape.



Distance

Angle	Distance
5°	10 in
10°	2 ft 8 in
20°	3 ft 8 in
25°	4 ft 8 in
30°	5 ft 9 in
35°	7 ft
40°	8 ft 5 in
45°	10 ft
50°	11 ft 11 in
55°	14 ft 4 in
60°	17 ft 4 in
65°	21 ft 5 in
70°	27 ft 6 in
75°	37 ft 4 in
80°	56 ft 9 in



Using the Compass

A compass is a device that uses a magnetic needle to determine direction. Lewis and Clark took a compass with them on their historic expedition from 1804 to 1806. Since that time, the compass has changed very little. The compass here is made of plastic and was purchased at a sporting goods store, but it works exactly the same as the compass used by Lewis and Clark.

To use a compass, you first need to learn your directions. Look at the face of the compass. The letters, N, S, E, and W stand for the directions north, south, east, and west. When you use a compass, the direction north (N) is the most important. That is because the red part of the magnetic needle *always* points to the Earth's magnetic north.

Modern compasses have a large red arrow in the center of the compass base called the *direction of travel arrow*. When you decide what direction you need to take, turn the dial on the compass (called the *compass housing*) so that the direction you would like to take is touching the *direction of travel arrow*.

After you have done this, turn your body with the compass until the red end of the needle is pointing north on the *compass housing*. Be sure to hold the compass flat so that the needle can spin freely. Now walk in a straight line following the *direction of travel arrow*. You should be heading in the direction you chose.



Dead Reckoning

When William Clark needed to measure distance quickly, he used a method called *dead reckoning*. By knowing how fast he was walking, or how fast their boat was moving on the river, and for what amount of time Clark could figure out the distance he had traveled.

To dead reckon, you need to know your *personal* walking speed. Stretch your tape measure out to a nice round number, such as 20 feet or 30 feet. Walk from one end of the tape measure to the other at your normal walking speed. Time yourself with the stopwatch to see how long it takes. Divide the number of feet you walked by the time it took you. For instance if it took you 10 seconds to walk 20 feet, your walking speed is 20 divided by 10, or two feet per second. You may want to time yourself a few times to get your average speed.

Now pick two points. Walk between them and time yourself with the stopwatch. Now take the number of seconds you walked and multiply by your walking speed. This should give you the distance between the two points in feet. Check your answer using the tape measure. How accurate were you?



The Dead Reckoning Line

To figure out speed from a boat in the ocean or on a river, like Lewis and Clark, a dead reckoning line is needed. A dead reckoning line is simply a piece of wood tied to a knotted line. The piece of wood, which was called a log, acted as a weight for the line. It was dropped overboard and stayed in place as the ship moved. Someone on the ship would hold the line and count the number of knots that passed through his or her hand in a certain period of time.

Since they wanted to know their speed in nautical miles per hour (a nautical mile is 6080 ft, 800 ft longer than a mile on land), they needed to know how many knots went over the side of the ship in an hour. To make it easier to count, they used a ratio, and figured out that putting a knot every 47.3 ft, and counting for 28 seconds would give them the same result as putting a knot at every foot, and counting for 3600 seconds, which equals one hour.

Once Lewis and Clark figured out how quickly they were traveling, they could multiply that speed by the amount of time that they traveled to figure out their distance.

Our dead reckoning line is a miniature version of the type of line that Lewis and Clark would have used aboard their keelboat. The knots in our line are 4.73 inches, rather than 47.3 feet, which is a scale of one inch to every 10 feet. Pull the knots through your hand and try to count how many have slipped through your fingers. Do you think that dead reckoning onboard Lewis and Clark's keelboat would have been easy, or difficult?



Lewis & Clark's Route to the Pacific Ocean

"By Land from the U. States in 1804 & 1805"

William Clark carved these words into a tree near the estuary of the Columbia River (an *estuary* is the area where a river's current meets the ocean's tide). From May 14, 1804 to November 16, 1805, Lewis and Clark and the Corps of Discovery traveled approximately 6,697 miles. During that time, they experienced many difficulties and challenges. Imagine their excitement when they reached the Pacific Ocean!