Surveying: 19 Chains and 50 Links

Objective

Students learn about land surveying and the Homestead Act. Students solve mathematical problems related to land surveying.

Background

Surveying is the technique of measuring to determine the position of points, or of marking out points and boundaries. These points may be above, beneath, or on the earth's surface.

Surveying is as old as civilization. It dates back to early Egypt. Every year, after the Nile River flooded and washed out farm boundaries, new boundaries were fixed by surveying. Three of the four presidents depicted on Mount Rushmore started as surveyors—George Washington, Thomas Jefferson, and Abraham Lincoln.

From colonial times and through the 1800s surveying was performed using a crude transit, or compass, and a chain. The chain was designed by Edmund Gunter in the late 1500s and is sometimes referred to as "Gunter's chain." The most common chain used was 66 feet long and had 100 links. Each link was equal to 7.92 inches. The compass was mounted on a tripod or a single pole, called a "Jacob's Staff." These tools were cumbersome to carry and difficult to maneuver through thick brush. More modern methods of surveying include the Theodolite, an electronic distance measurement, GPS (Global Positioning System), and robotic surveying systems.

The Land Ordinance of 1785 was adopted by the US Congress on May 20, 1785. Under the articles of Confederation, Congress did not have the power to raise revenue by direct taxation of the inhabitants of the United States. Therefore, the immediate goal of the ordinance was to raise money through the sale of land in the largely unmapped territory west of the original colonies acquired from Britain at the end of the Revolutionary War.

The 1785 ordinance laid the foundations of land policy in the United States of America until passage of the Homestead Act in 1862. The Land Ordinance established the basis for the Public Land Survey System. The initial surveying was performed by Thomas Hutchins. After he died in 1789, responsibility for surveying was transferred to the Surveyor General. Land was to be systematically surveyed into square "townships," six miles (9.656 km) on a side. Each of these townships was sub-divided into thirty-six "sections" of one square mile (2.59 km2) or 640 acres. These sections could then be further subdivided for sale to settlers and land speculators. Most pioneer farmers couldn't plant a whole section. Generally settlers started with 80 acres, with several pioneer families living on a single section of land.

When the government had surveyed the land, they set up a land office, where they sold the land at auctions. Another way the settlers acquired land was from the railroad companies. The government gave land to the railroad

Oklahoma Academic Standards

GRADE 6

Number & Operations: 3.3; 4.1,2,4. Algebraic Reasoning: 1.1; 3.1. Geometry & Measurement: 3.2; 4.3

GRADE 7

Number & Operations: 2.3,5. Algebraic Reasoning: 2.2; 3.3. Geometry & Measurement: 2.2; 4.2

GRADE 8

Social Studies Content— 2.2; 3.1; 6.4

Materials

ruler

yard/meter sticks

protractor

calculator

yarn/string

construction stakes

hammer

10' or 25' measuring tool

computer access

companies to encourage them to build railroad lines in the new territories. The railroad companies would sell some of the land to farmers.

The 1785 ordinance also established a mechanism for funding public education. Section 16 in each township was reserved for the maintenance of public schools. Many schools today are still located in section sixteen of their respective townships, although a great many of the school sections were sold to raise money for public education. In theory, the federal government also reserved sections 8, 11, 26 and 29 to compensate veterans of the Revolutionary War, but examination of property abstracts in Ohio indicates that this was not uniformly practiced. The Point of Beginning for the 1785 survey was where Ohio (as the easternmost part of the northwest Territory), Pennsylvania and Virginia (now West Virginia) met, on the north shore of the Ohio river near East Liverpool, Ohio. There is a historical marker just north of the site, at the state line, where Ohio Route 39 becomes Pennsylvania Route 68.

In May of 1862, Congress passed the Homestead Act. It provided that any person over 21 who was the head of a family and either a citizen or an alien who intended to become a citizen could obtain the title to 160 acres (65 hectares) of public land if he/she lived on the land for five years and improved it. Settlers could also pay $1.25 per acre in place of the residence requirement. It was thought that the land was worthless until improved, and homesteaders should not have to pay for the land if they were willing to improve it by turning it into farms.

The Homestead Act attracted thousands of settlers to the West. From 1862 until 1900, it provided farms and new homes for between 400,000 and 600,000 families. As families arrived, the federal government had to survey the land.

For "No Man's Land" and the "Unassigned Lands" of Oklahoma, the Indian Meridian and Indian Base Line were established at approximately twelve miles west of the 97th Meridian. As provided in 1866, with treaties between the US government and the Choctaw and Chickasaw nations, Indian land east of the 98th meridian was surveyed according to the public land survey system of the US General Land Office. Established in 1785, this system of land survey used a mathematically determined method to divide the public domain into standard units called "sections." From the Initial Point (Fort Arbuckle—approximately six miles west of the present town of Davis), a north-south line (Indian Meridian) and east-west line (Indian Base) were drawn. Eventually all the mapping and surveying would become boundary lines from which thousands made the Land Run of 1889 into the "Unassigned Lands" of Oklahoma.

Vocabulary

boundary—anything marking a limit or border

chain—a 66 foot length in surveying made up of 100 links

compass—instrument for showing direction by using a magnetic needle which always points north

domain—land or territory belonging to one government or person

Global Positioning System (GPS)—a system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on earth by calculating the time difference for signals from different satellites to reach the receiver

hectare—metric measure of surface equal to 10,000 square meters or 2.471 acres

meridian—any of the lines of longitude running north and south on a map or globe

robotic—an automated device to take the place of human manual work

transit—a surveying instrument for measuring horizontal angles

Background Sources: Bradley, Harold W., "Homestead Act," *World Book Encyclopedia*; Straus, E. G., "Gunter 's Chain," *World Book Encyclopedia*; "Land Ordinance of 1785," *Wikipedia, The Free Encyclopedia,* http://en.wikipedia.org/wiki/Land_Ordinance_of_1785; "A Brief History of Land Surveying," http://www.plsurvey.com; "Surveying Land," http://www.campsilos.org; Chapman, Berlin B., Indian Meridian, Archives and Manuscripts Division, Oklahoma Historical Society, 1967.

Social Studies

1. Read together and discuss the background information to familiarize students with surveying and its purpose.
   —Students will give examples of the uses of surveying today.
   —Introduce/discuss the vocabulary.
2. Discuss the Homestead Act of 1862.
   —Were the original purposes for the Homestead Act successful?
   —What problems or concerns arose?

Math

1. Hand out Worksheet A and review with students.
   —Discuss the terminology of measurement used in surveying.
   —Compare the measurements to standard or metric units used today.
   —Students will complete Worksheet A using the information given.
   —Discuss the problems or concerns students had relating to the conversion of measurements.
2. Hand out Worksheet B and review with students.
   —Discuss the surveying terminology of townships and sections.
   —Divide students into groups of three or four.
   —Students will work together to complete the surveying.
   —Students will complete Worksheet B, using their geometric skills to physically stake out plots on the school grounds.
   —Students will use protractors to accurately find the angles on their plots.
   —Students will exchange work areas with another group and check the accuracy of that group's survey work.
   —Discuss the problems of physically completing this activity rather than doing it on paper.
   —What would have been some problems with surveying land in the early 1800s?

Extra Reading

Harlan, James D., and James M. Denny, *Atlas of Lewis and Clark in Missouri,* University of Missouri, 2003.

Lasky, Kathryn, *The Journal of Augustus Pelletier: The Lewis and Clark Expedition (My Name is America)*, Scholastic, 2000.

Laurence, Edward, *The Young Surveyor's Guide: Or, a New Introduction to the Whole Art of Surveying Land: Both by the Chain and all Instruments Now in Use*, Nabu, 2010.

MacLauchlan, Patricia, *Caleb's Story*, HarperTrophy, 2002.

Panchyk, Richard, *Keys to American History: Understanding Our Most Important Historic Documents*, Chicago Review, 2009.

Petersen, Christine, *Colonial People: The Surveyor,* Benchmark, 2010

Name_____

Surveying: 19 Chains and 50 Links A

Surveying units:

Chain = 66ft. or 20 meters (100 links)
Link = 7.92 inches
Rod/perch/Jacob's pole = 16.5 feet
80 chains = 1 mile
100 square chains = 10 acres square
square 1 chain = the width of many rural roads

Furlong/furrow long = 660 ft.
Mile = 5280 ft. or 1760 yds.
Township = square of land 6 miles by 6 miles
Township = 36 sections
Section = 640 acres or 1 mile

Use the above information to complete the activities below. Please show your computations.

1. Draw a township, including the 36 sections. (.25 inches = 1 mile)

2. Most early settlers could only farm 80 acres. How many 80-acre plots are included in a township?

3. A Jacob's pole is 3 fathoms or 16.5 feet long.

a. How many poles would equal 1 chain?

b. How many links would equal one pole?

4. Surveyors used stakes to mark the end of each chain. If they were surveying a square plot of 10 acres per side, how many stakes would they need?

5. How many chain lengths would be needed to survey a township? (Perimeter measurement)

6. How many chains and links would be needed to plot a distance of 8000 feet?

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Name_____

Surveying: 19 Chains and 50 Links

(answers)A

Surveying units:

Chain = 66ft. or 20 meters (100 links)
Link = 7.92 inches
Rod/perch/Jacob's pole = 16.5 feet
80 chains = 1 mile
100 square chains = 10 acres square
square 1 chain = the width of many rural roads

Furlong/furrow long = 660 ft.
Mile = 5280 ft. or 1760 yds.
Township = square of land 6 miles by 6 miles
Township = 36 sections
Section = 640 acres or 1 mile

Use the above information to complete the activities below. Please show your computations.

1. **Draw a township, including the 36 sections. (.25 inches = 1 mile)**
   Answer: Each side of the township should measure 1 1/2 inches.

2. **Most early settlers could only farm 80 acres. How many 80-acre plots are included in a township?**
   Answer: Each section = 640 acres ÷80 acres = 8 farm plots
   36 sections (1 township) x 8 farms = 288 plots

3. A Jacob's pole is 3 fathoms or 16.5 feet long.

a. **How many poles would equal 1 chain?**
   Answer: 1 chain = 66 ft. 66ft.÷16.5ft.= 4poles

b. How many links would equal one pole?
   Answer: 1 link = 7.92 in 1 pole = 16.5 ft. or 198 in.
   198 in. ÷ 7.92 in. = 25 links

4. Surveyors used stakes to mark the end of each chain. If they were surveying a square plot of 10 acres per side, how many stakes would they need?
   Answer: 10 chains per side
   4 corner stakes + 9 stakes per side
   9 stakes x 4 sides + 4 corners = 40 stakes

5. **How many chain lengths would be needed to survey a township? (perimeter measurement)** Answer: 80 chains per mile
   6 miles x 4 sides = 24 miles perimeter
   24 miles x 80 chains = 1920 chain lengths

6. **How many chains and links would be needed to plot a distance of 8000 feet?** Answer: 1 chain = 66 ft.
   8000 ft. ÷ 66 ft = 7986 ft. (121 chains)
   8000 – 7986 = 14 ft. or 168 inches
   168 in ÷ 7.92 in = 21.21 links
   Final answer: 121 chains and 21.21 link

Name_____

Surveying: 19 Chains and 50 Links B

As a surveyor, you will be marking out sections of land. All angles and measurements need to be exact.

1. Survey a square plot of land with sides of 25 links. (A link equals 7.92 inches.) Draw and label your plot when finished surveying.

2. Survey a triangular plot of land. The plot forms a right triangle whose base is 3 ft. long and contains a 60- degree angle. Draw and label your plot when finished with the measurements of all three sides and angles.

3. Your choice! Complete the survey of a plot, which is a geometric polygon and has 6 or fewer sides. Be sure to draw and label a diagram of your plot with angles and sides.

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Name_____

Surveying: 19 Chains and 50 Links (answers)B

As a surveyor, you will be marking out sections of land. All angles and measurements need to be exact.

1. Survey a square plot of land with sides of 25 links. (A link equals 7.92 inches.) Draw and label your plot when finished surveying.

Answer: 25 links x 7.92 in = 198 inches or 16.5 ft. or 5.5 yds

Drawing: a square with 90 degree angles

2. Survey a triangular plot of land. The plot forms a right triangle whose base is 3 ft. long and contains a 60- degree angle. Draw and label your plot when finished with the measurements of all three sides and angles.

Answer: The angles of the right triangle should be 30, 60, and 90 degrees respectively.

The sides of the triangle should follow the formula 3 squared + "b" squared = "c" squared with "c" being the hypotenuse of the triangle.

3. Your choice! Complete the survey of a plot, which is a geometric polygon and has 6 or fewer sides. Be sure to draw and label a diagram of your plot with angles and sides.

Answers will vary depending on the choice of design.

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.