

REAL LIFE REAL WORLD Activity: Surveying Rotations, Areas of Triangles & Trigonometry

Topic: Rotations, Area of Triangles & Trigonometry

Grade Level: 9 - 12

Objective: To create a plot plan with geometry software and to calculate the area of the land parcel.

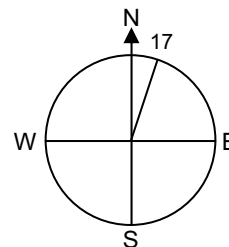
Time: 45-60 minutes

Introduction

Surveyors describe land parcels with distance and angle measurements. The angle measurements are often given as *compass headings*. Once the boundaries of the land parcel are described, the surveyor can calculate the area of the land.

Discuss with Students

Compass headings are one way to describe angles. They give a compass point (North, South, East, or West), a number of degrees, and then another compass point. For example, N 17 E is a compass heading that means 17° east of due north.



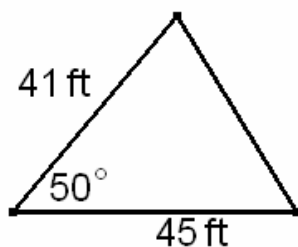
1. Draw a circle diagram to correspond to each compass heading:

- A. N 85 E B. S 9 W C. N 45 W D. S 21 E

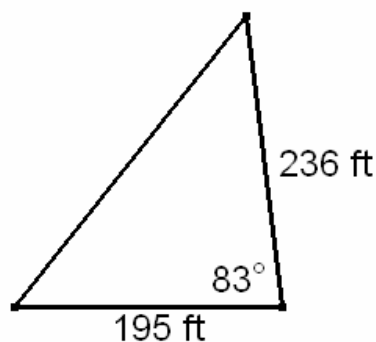
The formula for the area of a triangle is $\text{Area} = \frac{1}{2} \text{Base} \times \text{Height}$. However, in the case of a survey, it is sometimes easier to use the formula $\text{Area} = \frac{1}{2} ab \sin C$, where a and b are sides of a triangle and C is the included angle. A land parcel can be divided into triangular regions and the areas can be added together to calculate the total.

2. Find the area of each triangle.

A.



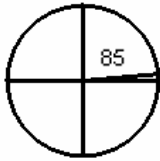
B.



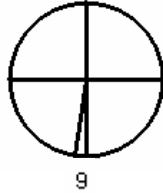
Note to Teachers: In Cabri Geometry, rotations are described in a counterclockwise direction. The compass headings N - - W and S - - E will both rotate the specified number of degrees in a counterclockwise direction, but the compass headings N - - E and S - - W will need to be adjusted by using negative degree measures. The sample parcel in the Activity happens to use only counterclockwise rotations.

Discuss With Student Answers

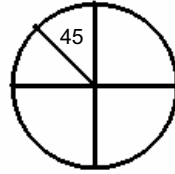
1A.



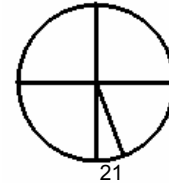
1B.



1C.



1D.



2A. 706.7 feet² 3B. 22,838.5 feet²

Student Page Answers

Activity 1

10. The final diagram of the sample parcel is shown in Figure 1. The construction lines are hidden in Figure 2.

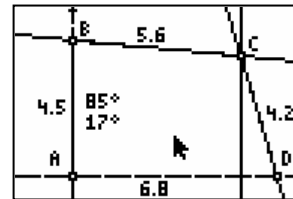


Figure 2

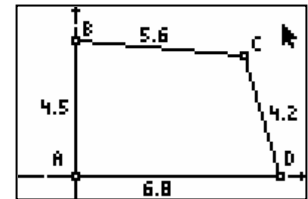


Figure 1

Activity 2

4. The calculated area of the parcel is 26.208 units². Each unit on the figure was equal to 10 yards (since 45 yards were represented by 4.5 units, etc.). Therefore the area of the parcel is 2620.8 yards².

Extension 1

The area is equal to 23587.2 feet² and approximately 0.54 acres.

Technology Reference

This activity uses the following Cabri Jr. functions:

- | | | | | | | | |
|----|----------|----|---------------|----|----------|----|----------------------|
| F2 | Point | F3 | Perpendicular | F4 | Rotation | F5 | Hide/Show |
| | Line | | Parallel | | | | Alph-Num |
| | Segment | | | | | | Measure: D. & Length |
| | Triangle | | | | | | Measure: Angle |
| | Quad. | | | | | | Measure: Area |

Refer to "Getting Started with Cabri Jr." for more details.

Name _____ Date _____

REAL LIFE REAL WORLD Activity: Surveying

Surveyors describe land parcels with distance and angle measurements. The angle measurements are often given as *compass headings*. Once the boundaries of the land parcel are described, the surveyor can calculate the area of the land.

Activity 1

Create a diagram that represents a sample parcel of land. The boundary description is:

Begin at the marked point at the SouthWest corner of the property.

45 yards due North

56 yards S 85 E

42 yards S 17 E

68 yards due West

The Coordinate Axes will be used to create North-South lines for the compass headings.

- Show the Coordinate Axes. Drag the origin to the lower left corner of the screen. Label the origin *A*. See Figure 1.
- Create the first property boundary. See Figure 2.
 - Construct a segment with one endpoint *A* and other endpoint on the *Y*-axis.
 - Label this endpoint *B*.
 - Measure \overline{AB} .
 - Drag point *B* so that the length of \overline{AB} is 4.5 (to represent 45 yards).
- Place the numerical value 85 on the screen.
 - Select the Alph-Num tool.
 - Press **ENTER** to begin the text in a desired location.
 - Press **ALPHA** to use numerical characters.
 - Press **ENTER** to finish the text.
- Rotate the *Y*-axis line through *B* with rotation 85° . Hide any points that appear on the rotated line. See Figure 3.
- Create the second property boundary. See Figure 4.
 - Construct a segment with one endpoint *B* and the other endpoint on the rotated line.
 - Label this endpoint *C*.
 - Measure \overline{BC} .
 - Drag point *C* so that the length of \overline{BC} is 5.6.

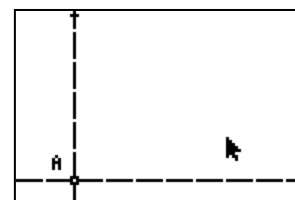


Figure 1

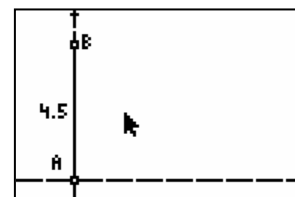


Figure 2

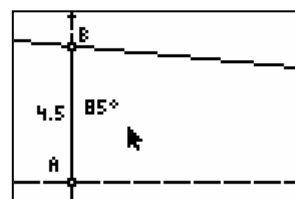


Figure 3

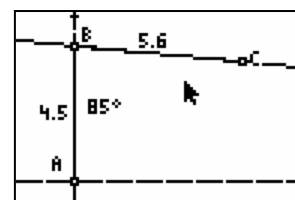


Figure 4

6. Create a North-South line through point C parallel to the Y-axis (or perpendicular to the X-axis). See Figure 5.

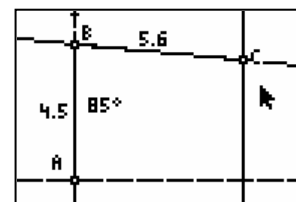


Figure 5

7. Put the numerical value 17 on the screen.

8. Rotate the N-S line through C with rotation 17.

9. Create the third property boundary. See Figure 6.

- Construct a segment with one endpoint C and the other endpoint on the rotated line.
- Label this endpoint D.
- Measure \overline{CD} .
- Drag point D so that the length of \overline{CD} is 4.2.

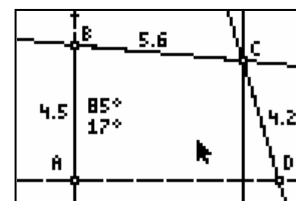


Figure 7

10. Point D should be located on the X-axis. Create the fourth property boundary by connecting D to A with a segment. Confirm that the length of \overline{AD} is 6.8.

Activity 2

Divide the parcel into triangles and find its area.

1. If desired, hide the construction lines and rotation angles from Activity 1.
2. Construct a segment that divides the parcel of land into two triangles (connect either A and C or B and D).
3. Measure the pair of opposite angles that are *not* connected by the diagonal. See Figure 7.

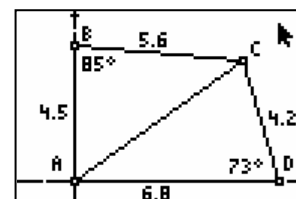


Figure 8

4. Use the formula $\text{Area} = \frac{1}{2} ab \sin C$ to find the calculated value of each triangle. Add these values to find the total area.

5. Overlay a quadrilateral on the vertices A, B, C, and D. Find its area and compare it to the calculated area.

Extensions & Resources

Extension 1

An acre is equal to 43,560 feet². The dimensions of the sample parcel were given in yards. Convert each dimension to feet and calculate the area of the parcel in feet² and acres.

Extension 2

Create a quadrilateral and measure its sides and angles. Use compass headings to describe your "parcel" of land and determine its area.

Websites to explore:

<http://www.nps.gov/gewa/ed/67/67home.htm>

Many colonial leaders also were surveyors. This site explains how George Washington used surveying and other math and science concepts.

<http://surveying.wb.psu.edu/psu-surv/SURIs/index.htm>

Learn more about surveying and related occupations.