Name: ____________________________ Class: _______ Date: ______________

How Far Is It?

Learner Outcomes:

- Describe and interpret, in general terms, the technologies used in global positioning systems and in remote sensing (e.g., use triangulation to determine the position of an object, given information on the distance from three different points)

Key Terms:

GPS	Remote Sensing	Triangulation

Background Information: Triangulation is based on the geometry of a triangle. By measuring the angles between a baseline and the target object, you can determine the distance to that object. GPS units use triangulation to determine the position of objects from space. Satellite technology collects information about the distance between an individual satellite and the earth. This data is collected by multiple satellites and triangulated to give a measurement of where an object is.

Research Question: How accurately can the length of a playing field be measured using triangulation.

Materials:

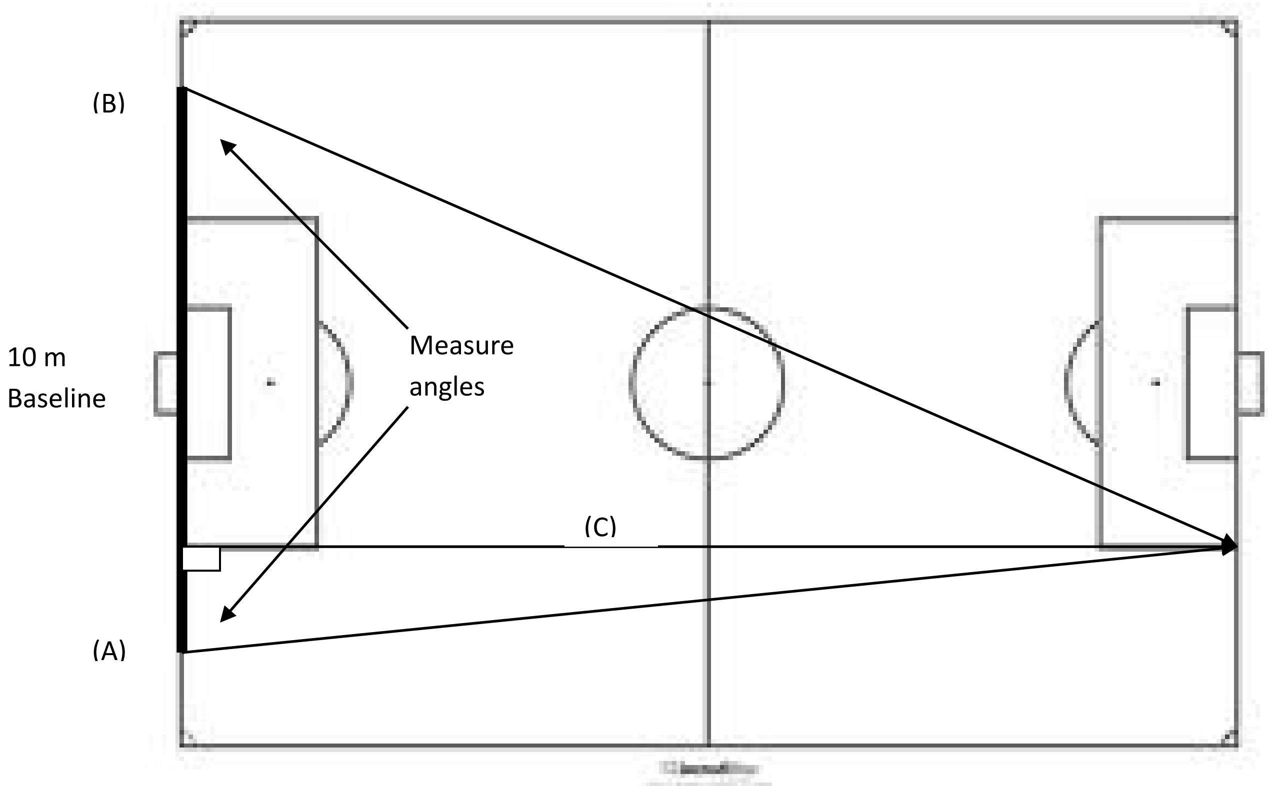
Measuring tape	protractor	pencil
meter sticks	paper	ruler

Procedure:

1. Select a flat area, ideally a soccer or football field with goalposts at both ends. If there are no goal posts, create you own by inserting 2 pairs of meter sticks or placing pilons on / in the ground.
2. Use the measuring tape to measure off a baseline of 10 m along one goal line of the field.

This investigation / activity has been adapted from:
Mah K, Martha J, McClelland L, et al. *Science in Action 9.* Toronto, ON: Addison Wesley.

3. Mark each end of the baseline with meter sticks or pilons to serve as guideposts. Mark each end of your baseline (A) and (B).
4. Standing at the end of the baseline (A) look directly at the right goal post at the far end of the field and measure the angle between this line and the baseline. Record your data. Repeat for the other end (B).



5. Repeat steps 2-4 using a 20 m and then a 50 m baseline.
6. Find and record the actual length of the field (line C) by asking the teacher, or measuring the distance.

Observations:

Baseline length (m)	Angle from (A) °	Angle from (B) °	Calculated length of field (m)	Actual length of field (m)	Percent error %
10					
20					
50					

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Analysis:

1. For each baseline length, make a scale drawing of a triangle, using the two angles you measured each time. Use a scale of 1cm = 5m.
2. On each of your scale drawings, measure the length of the field (line C) and record your results.
3. Calculate the accuracy of your results using the percent error equation below.

$$\% \text{ error} = \frac{(\text{Actual field} - \text{Measured value})}{\text{Actual value}} \times 100\%$$

4. How accurate was your calculated length of the playing field?

5. Which baseline measure gave you the most accurate measurement? Why?

6. What would be some sources of error in this activity?

Conclusion: How accurate is triangulation.

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Extension:

1. Write a procedure to explain how triangulation could be used to determine the distance of objects (stars or satellites) in space. Identify some of the variables you must control to ensure the results are as accurate as possible.
2. Create a poster or illustrative diagram that explains how triangulation is used to determine your specific location on earth, using GPS technology.

Analysis:

1. Do your coordinates match those of any of your classmates? Explain.

2. Imagine that after locating the position of a star, you send the coordinates to the Astronomical society. A week later, they call to say they followed your directions exactly, but could not find the star. What might have happened that would make your coordinates incorrect?

3. What additional information do you need to locate a star?

4. If you were looking at a real star and you took the coordinates every night for one full year, from the same location, would the coordinates change or remain the same. Explain your answer.

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Conclusion:

Extension:

1. You can record the altitude of the sun with an astrolabe. Point the straw at the sun with one hand, and hold your other hand, palm up to the other end of the straw. Move the straw until you see a small circle of light on the palm of your hand. Read the angle on your cardboard scale to get the altitude of the sun. Take three measurements and calculate the average. Try this at the same time for five days in a row. Does the sun's altitude change, or does it stay the same? Explain.

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