Down to Earth
KS3

## Teachers! Guide

# Following the Falling Meteorite

# Follow the Falling Meteorite

## Background

Triangulation is a geometric technique for locating distant objects or events by measuring the directions to an object from two known locations. The basic premise behind triangulation is that many of our senses can accurately determine the direction to an object but cannot always accurately determine its distance.

However, two observers in different locations will see the object in different directions. The two known locations of the observers form the base of a triangle. The angles to the distant object define where that object is located, as seen below.

Triangulation is used extensively in astronomy to determine distances or sizes of objects we cannot visit (like stars and planets).

Triangulation is a useful map and survival skill often taught in orienteering. This technique is used in surveying. It is a good introduction to the geometry and mathematics of triangles.

In this lesson students use sound to demonstrate basic triangulation techniques. They also triangulate using a meteor’s path to predict where meteorites might be found. Extended maths applications may be added.

## Objectives

Students will:

- Apply geometric properties and relationships to meteorite hunting.
- Demonstrate the way remote objects can be accurately located by triangulation.
- Use triangulation on a map, in a directed activity and in a group-challenge.

# Follow the Falling Meteorite

## 1: Listening for the Meteor

### Overview

Students will demonstrate how to locate distant objects or sites by triangulation.

They will use sound to show the basic principles of triangulation. This activity can be done indoors or outside.

### Materials for Activity 1

blindfolds for two

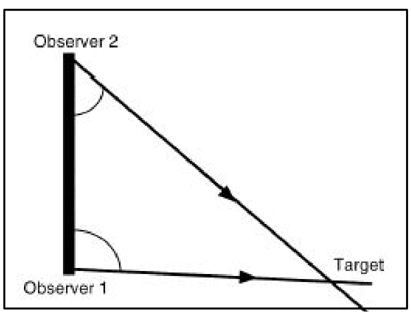
noise maker *(anything noisy, to simulate a meteorite impact)*

string *(enough to 'trace' the triangle)*

### Management

1. Choose a student to be the listener, and another to make the noise (drum, pencil tapping etc.). Make sure that the listener cannot (or will not) see during the procedure, as by blindfolding. Have the noise maker go to a far point in the room, moving quietly or masked by noises made by the other students. When the room is quiet again, have the noise maker make a sound. Repeat if necessary until the listener points at the noise maker. Most students should be able to pinpoint the direction of the noise maker.

   Ask the blindfolded listener to determine the distance to the noise maker. Show the students that a single listener can tell the direction to the noise, but not always the accurate distance.
2. Choose two students to be listeners and repeat as in step 1, keeping as much distance between them as possible. Both listeners should pinpoint the noise maker fairly accurately. Show how the location accuracy is improved by using two observers. To make it easier for students to see the triangle, try using string to trace the visual lines of sight.
3. Repeat with more than two listeners if desired. A small 'target area' will usually be formed.



## 2: Path and Speed of a Meteor

### Overview

Students will track a meteor's path using triangulation and predict where its meteorites might be found. The exercise can be extended to calculating the velocity of a meteor and understanding how scientists can determine a meteor's original orbit in space.

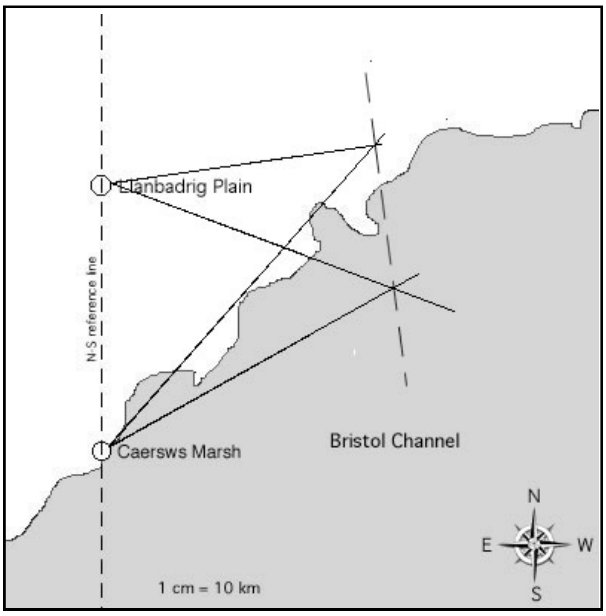
### Materials

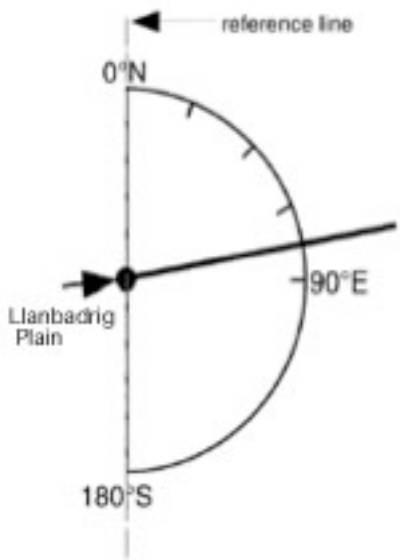
| | |
|---|---|
| Protractors | rulers |
| Student Worksheet | coloured pencils |

### Management

1. Review use of protractors, map coordinates, map scale and units.
2. Practice several protractor readings (see example below).
3. Distribute 'Student Worksheet'.
4. Allow students to complete the worksheet.
5. Discuss.

### Map



## Answers

1. Where do the two lines cross?

**40-43 km East-Northeast of Llanbadrig Plain.**

2. Where did the meteor explode?

**In the air near where the lines crossed, or same answer as first question.**

3. Where was the meteor when the spark flew?

**50-52 km northeast of Caersws Marsh, or near the coastline by the peninsula.**

4. Using the positions of the spark and the explosion, which direction was the meteorite travelling?

**North-Northwest**

5. How far was it from where the meteorite sparked to where it exploded?
**23-25 km**

6. Where would you first look for meteorites that might have fallen from the explosion?

**Northeast of Llanbadrig Plain, near where the lines cross.**

7. If both observers counted two seconds between the spark and the explosion, how fast was the meteor going?

**Approximately 43,200 km per hour.**

## Extra Questions

1. Why might a meteor not produce meteorites?

**The meteorite might burn up before landing.**

2. Could a meteorite fall without anyone seeing a meteor? Explain.

**Yes. Meteors can be small enough and slow enough that they do not make big meteor streaks in the sky; no one saw a meteor when Noblesville fell. Also, it might fall at a time or remote location where no one is looking.**

3. How could you determine the elevations of the meteor's sparking and its explosion?

**You can calculate the height using the determined distance and the measured observed angle above the horizon h = d Tan angle.**

4. What information would you need to determine the orbit a meteorite was in orbit before it hit the Earth?

**You would need several accurately located photo observations of the meteor with exact time records, and data charts of Earth's positions.**

### Extensions

1.Try depicting this activity in 3 dimensions by providing altitude angles. Challenge students to come up with a way of representing the true meteor location.

2.For students with a background in algebra and trigonometry, the location of the meteor spark and explosion in Activity 2 can be determined mathematically using the cosine rule.

# Meteorite Treasure Hunt

## Overview

This triangulation activity can be done as a treasure hunt game using a map of your local area. Each team creates directions that allow another team to determine the fall site.

## Materials

| | |
|---|---|
| copies of local map | coloured pencils |
| paper | protractor *(per team)* |

## Management

1.Decide where on the map the two observers would be.

2.Divide the class into teams and give each team two copies of the map.

3.Each team chooses a meteorite fall spot, and marks it with a dot on one map. Determine what direction the observers would have had to look to see the meteorite fall point. Draw lines from the fall point to where each observer is stationed.

4.Measure the angle those lines make with North. At the bottom of the second map or a piece of paper, record these angles for use by another team.

5.Each team passes their list of angles to another team so that they have 'directions' for a new meteorite fall. Then use triangulation as in Activity 2 to determine where the meteorite fell. This could be done as a race. After teams are finished, they can compare their fall location with the original maps.

## Extensions

1.Outside, set up the treasure hunt so that students learn to use a magnetic compass.

2.Place a ball bearing in a field to represent a meteorite.

Provide a map of the field and triangulation observation angles.
Have students attempt to find the 'meteorite'.