



Physics Education Program

Name: _____

Teacher: _____

School: _____

Triangulation Device

student activity

Key Ideas

Mathematical background and trigonometry

Equipment

Stiff white cardboard or protractor
 Small washer
 Drinking straw
 Black string
 Sticky tape
 Scissors

50m tape measure or trundle wheel
 Paper, pens and clip board
 Trundle wheel

This activity should be completed before you visit Dreamworld.

Standard Achieved: Scientific Techniques and Scientific Investigation

VHA	HA	SA	LA	VLA	Not Attempted
<ul style="list-style-type: none"> applies technology to gather and record valid data and information with discrimination 	<ul style="list-style-type: none"> applies technology to gather and record valid data and information 	<ul style="list-style-type: none"> uses technology to gather and record data and information 	<ul style="list-style-type: none"> uses technology to gather and record data and information 	<ul style="list-style-type: none"> attempts to use technology to gather and record data and information 	<ul style="list-style-type: none"> not attempted
<ul style="list-style-type: none"> critically evaluates the investigation and reflects on the adequacy of the data collected and proposes refinements. 	<ul style="list-style-type: none"> evaluates the investigation and reflects on the adequacy of the data collected. 	<ul style="list-style-type: none"> discusses the investigation 	<ul style="list-style-type: none"> makes statements about the investigation 	<ul style="list-style-type: none"> attempts to make statements about the investigation 	<ul style="list-style-type: none"> not attempted

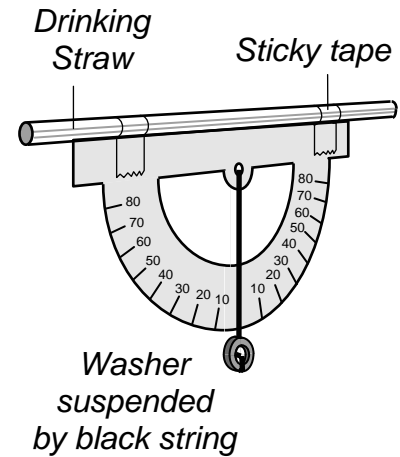
Triangulation

Introduction

Triangulation is a method used to measure the angle of elevation to a point of interest.

This useful method for measuring the height of structures is ideally suited to the activities to be conducted at Dreamworld. You can produce your own triangulation device and practice using it prior to the excursion to learn the practical methods of triangulation. Many of the materials required for constructing the device are likely to be found in your pencil case. Protractors with a ready-made hole are available from most stationery shops and can be kept for general use after the excursion. Alternatively, a protractor can be traced onto sturdy cardboard and the hole simply pierced with a compass point. This method is very accurate when objects to be measured are relatively close to the observer (for instance, devices which employ a telescopic sight and cross hairs give very accurate measures of angles for larger distances).

A clinometer is a useful pre-made triangulation device with a trigger to hold the reading.



A simple triangulation device

Theory of operation

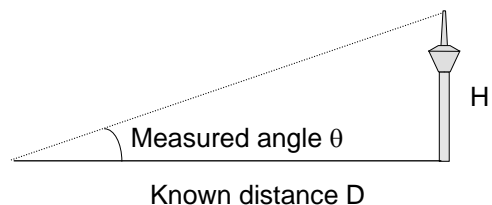
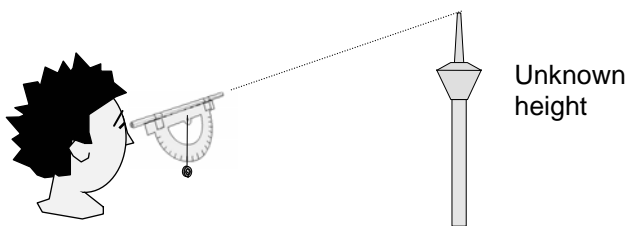
Method 1

This is the method which you will use on your excursion to Dreamworld. Triangulation is a simple method which exploits the geometry of right-angled triangles. The straw acts as a bore sight and allows the user to accurately aim the device and measure the angle from the horizontal to the point of interest as illustrated. If the horizontal distance to the base of the object of interest is known, the height is simply given by

$$H = D \tan \theta + e$$

Equation 5.1

(where e = height of eye above ground)



Practising measurements prior to your Dreamworld excursion will ensure that you can complete the worksheets in the time allocated. The horizontal distances from observation points to points of interest have been measured and are provided in your activity sheets since there is no access to the base of most rides, for safety reasons. The observation points are marked on the maps in your activity sheets.

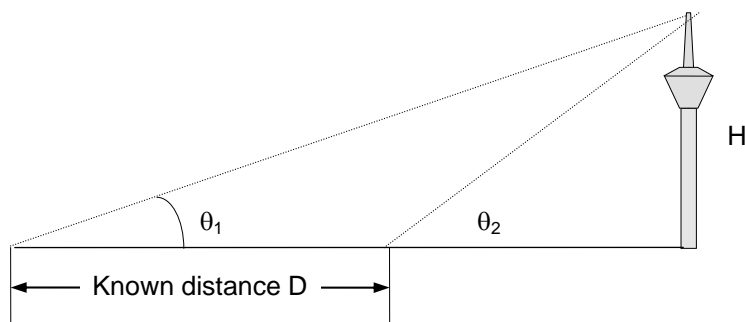
Method 2

A slightly more complicated method can be used when the horizontal distance to the object cannot be measured. In this method, illustrated below, the angle to the object of interest is measured from two places separated by a known distance, and both on the same line to the object. In this case, the height of the distance object is given by

Challenge activity:
Derive equation 5.2.

$$H = D \frac{(\sin\theta_1 \sin\theta_2)}{\sin(\theta_2 - \theta_1)} + e \quad \text{Equation 5.2}$$

(where e = height of eye above ground)



Once the height of the structure has been determined, it is then easy to determine the distance to the structure of interest by rearranging equation 5.1. This technique is useful for measuring both the height of an object, and the distance between it and the observer. Once H is known, the distance to the object is easily determined using method 1.

Exercise**Objectives**

- To practise using equation 5.1 for the Dreamworld excursion
- To verify Method 2 and equation 5.2 by testing it on the same structure measured using Method 1.

Equipment required

Triangulation device
50 m tape measure or a metre wheel
Calculator
Pens, paper and clipboard

Procedure

Use a tape measure and your triangulation device to determine the height of a structure within the school grounds (such as a flagpole) using equation 5.1. Once the height of the structure is known, use method two to test the validity of equation 5.2. If the height is known, you can determine the accuracy of the triangulation method using your device.

Critically evaluates the investigation by reflecting on the adequacy of the data collected and propose refinements to improve your results. You could consider the sources of error with your device and propose a more accurate device (such as one which uses a telescopic sight with cross hairs to improve the accuracy of the angle measurement).