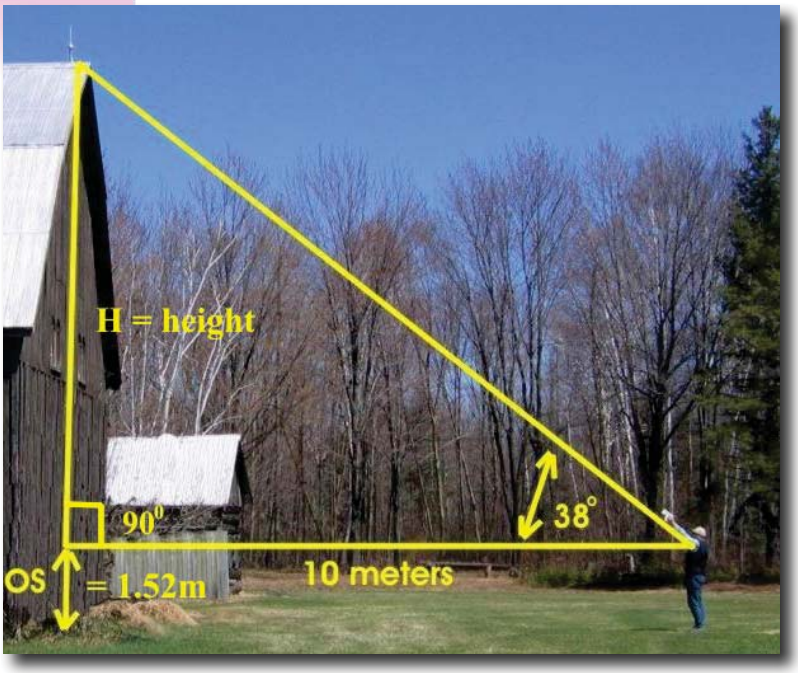
EXPLAIN

HOW CAN WE MEASURE THINGS IN SPACE?

MEASURING INTANGIBLE HEIGHTS

30 MINUTES



Using an inclinometer to measure an intangible height

SUMMARY

How do you measure something if it's out of reach? Whether it's a tall tree, a meteor or a far away star, a longer ruler just won't do. We use geometry and what we know about angles to measure intangible heights.

In this activity, we'll measure the angle to the top and the distance to the bottom of some tall things around the school grounds and draw a scale model. This will allow us to determine the object's height, and is a simple demonstration of how angles and geometry are used.

The Fireballs in the Sky team are 'teaching' the DFN software to determine the distance to a meteor by analysing the angle from the ground and known distances to other cameras.

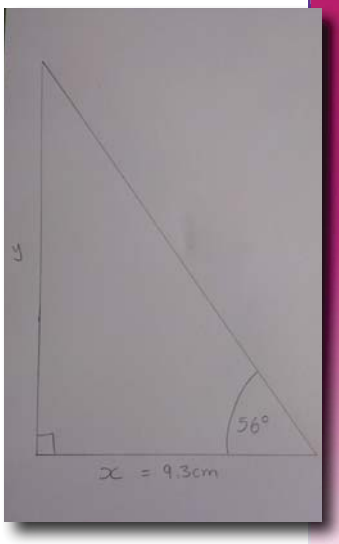
To measure the distance to other stars, astronomers use parallax. This is a more complex version of trigonometry than we will use here, but it is based on the fact that the Earth moves in space faster than stars do. At opposite ends of the Earth orbit (e.g. mid summer vs mid winter), we can measure the angle that the star in question has appeared to have moved, relative to the other stars. This is the same as when you focus on a point with one eye, then close it and open the other - you can use the apparent shift and the distance between your pupils to calculate the distance to the point.

OUTCOMES

1. Students create and use an inclinometer to calculate heights of objects around the school grounds
2. Students identify, estimate, measure and compare angles in everyday situations
3. Students draw a scale model with a protractor, using measured angles to determine an unknown

EQUIPMENT (PER PERSON/PAIR)

- Inclinometer template, page 65
- Intangible heights worksheet, page 66
- Protractor
- Ruler
- Grid paper
- Sticky tape
- 30cm lengths of String
- Weight with a hole in the middle e.g.20mm nut
- Thumb tacks



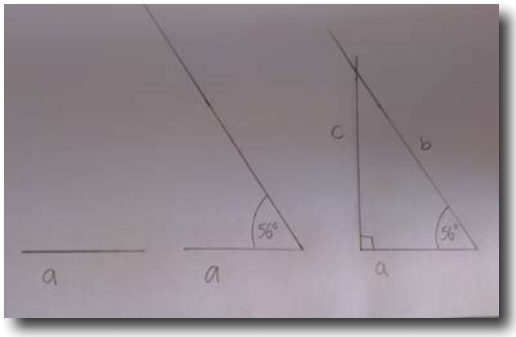
THE ACTIVITY

Set up:

Students discuss ways of measuring the height of a tall tree, building or flagpole. Introduce the idea of using right angle triangles by drawing two triangles:

1. Draw a large right-angle triangle on the board and measure the horizontal side (x) and one of the other angles.
2. Have students draw a scale model of the triangle on grid paper to determine the height of the triangle (y):
    - draw a horizontal line (a)
    - measure the angle from one end of the line
    - draw the hypotenuse line (b)
    - complete the triangle and measure the vertical line (c)
    - calculate the scale of small triangle

    (x ÷ a = y ÷c)
    - calculate y (y = x ÷ a x c)
    - check your calculations by measuring the height of the triangle on the board. Were you close?



Alternatively, make the task simpler by using a 1m:1cm scale.

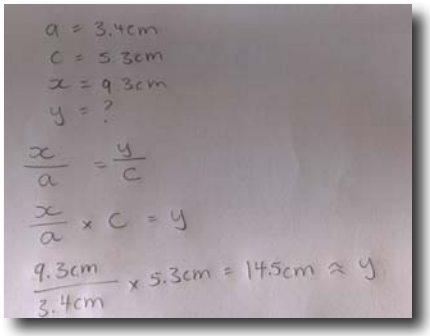
To measure the height of any tall object, we only need to know the angle to the top and the distance from the base to the measuring point.

Plan:

Students build an inclinometer, following the instructions on template.

Predict:

Students create a table for collecting the data they will need and estimate the height of various trees and buildings in the school grounds (see worksheet)



Calculating the height of a triangle

Test:

To use the inclinometer, hold it steady on the ground and sight the top of the object through the sight. Have a friend read and record the angle. Measure the distance from the base of the object to the recording point.

Because you are not measuring the angle from the ground, you will need to measure the distance from the object at the same height (e.g. at measurer's shoulder height). See the detailed instructions at the Hila Road centre for more information:

http://hila.webcentre.ca/projects/inclinometer/inclinometer3.htm

Analyse:

Students calculate the height of the objects using their recorded data and drawing scale images:

1. Calculate the scale distance for horizontal line (e.g. 15 m = 15cm)
2. Mark the angle on one end of the line, and draw the (hypotenuse) line to intersect with the vertical grid line
3. Complete the triangle and measure the vertical line
4. Calculate the actual height using the scale
5. Compare with estimate
6. Measure the perpendicular line to the edge of the triangle

Students determine how accurate their method is by using it on something for which they can measure the height (e.g. to the window sill).

Communicate:
Students discuss how they can use their inclinometer to measure the stars or moon – what useful information can be obtained? Students take home their inclinometer to measure the angle of the moon at e.g. 7 pm and explain the concept to someone at home.

SUGGESTIONS FOR THE CLASSROOM

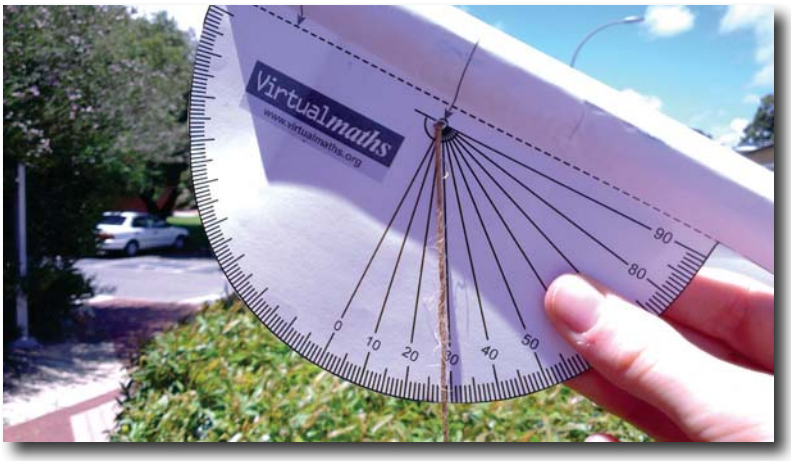
- Inclinometers are available on some compasses and there are many free as a smart phone or ipad app.Compare your own creation with this. What kinds of applications are there for this technology?
- The Fireballs in the Sky app uses the accelerometer in smart phones for exactly this purpose – to measure the angle a meteor was seen.
- More information on parallax can be found here:

http://science.howstuffworks.com/question224.htm

- More information, activities and instructions on using inclinometers can be found here:

http://www.virtualmaths.org/activities/shapes/theod2

http://hila.webcentre.ca/projects/inclinometer/inclinometer3.htm



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