



Trees and Math: Measuring Methods

Welcome to McGill University. Today, you will be identifying some of the 80 different species of trees found on the downtown campus, and learning how to estimate the height of those trees using some simple measurements. You can do this activity anywhere there are trees; your backyard, cottage, schoolyard, campus, etc.

Things you will need: 1) a copy of *A Leafy Legacy: The Trees of McGill University* or another tree identification guide; 2) a measuring tape; 3) a pencil; 4) a wax crayon; 5) paper towel; 6) clothing appropriate for the weather (this is an outdoor activity); 7) groups of 2-4 students.

Estimated activity time: 1.5 hours for 3 trees.

I. Identify your tree

- 1) Look around you at the trees on campus. Select a tree and, using *A Leafy Legacy: The Trees of McGill University* or another tree identification guide, identify the common and Latin names of this tree. In *A Leafy Legacy*, use the map on pages 16 and 17 to help you locate and identify your specific tree. Record this information in the **Results** chart.
- 2) Position a piece of paper towel against your tree at shoulder height. Hold the paper while your partner rubs over the bark with a wax crayon: this creates a bark rubbing. Label the paper towel with the name of the tree.
- 3) Gently remove one leaf per tree and place the leaf inside the folded paper towel. Place the paper towel into a sample bag and press the paper towel with the leaf inside between pages of a large book when you get home. After about one week, the leaf will have dried out. You can then laminate the leaf or iron the leaf between pieces of wax paper to preserve it.

II. Calculate the diameter of your tree

- 1) Using the measuring tape and starting from the ground, measure 1.4 metres (= average breast height) up the tree trunk. If the tree is on a slope, measure 1.4 metres on the side of the tree that is uphill. Have your partner(s) mark where 1.4 metres is with their hand.
- 2) Measure the circumference of the tree by wrapping the measuring tape around the smallest part of the trunk between the ground and the 1.4-metre mark. Read the measurement off the tape and record the circumference in metres in the **Results** chart. You may want to do this several times to be sure you have the tape properly positioned. Use the smallest of your measurements for step 3).
- 3) Calculate the mean diameter of the tree: divide your measured circumference by pi (=3.14). This is known as the DBH or "Diameter at Breast height". Record it on your **Results** chart in metres.

III. Calculate the height of your tree

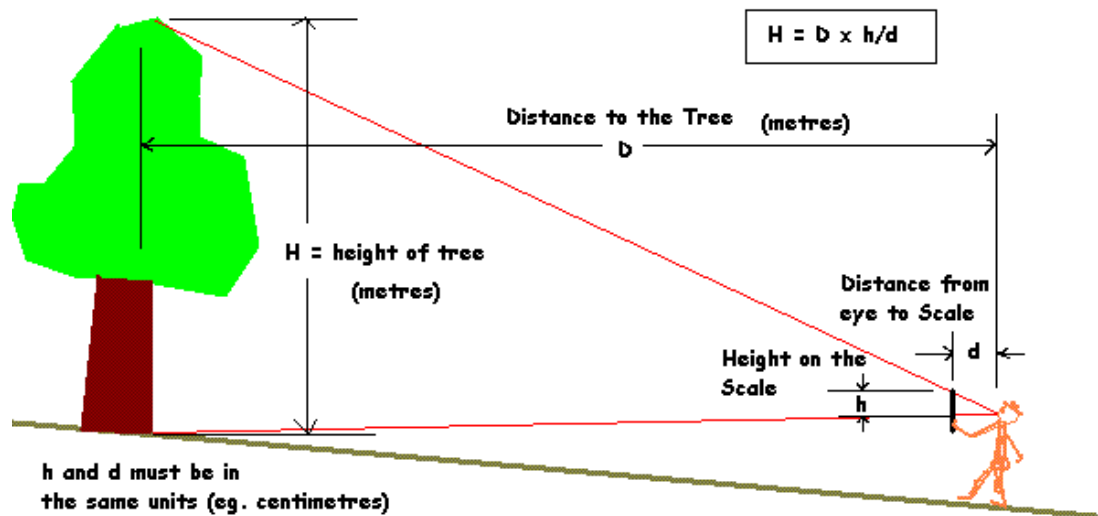
A) With a partner: the “height of a person” method

- 1) Choose one partner, measure his/her height in metres and record it here: _____.
- 2) Have this partner stand at the base of the tree. Standing in front of him/her, hold your pencil straight out in front of you and move slowly away from the tree until the top of the pencil is at the top of your partner’s head, and the bottom of the pencil is at the bottom of your partner’s feet.
- 3) Next, estimate how many pencil lengths it would take to reach the top of the tree. You can do this by flipping the pencil from end to end, up the tree.
- 4) Multiply this number by the height of your partner. For example, if your partner is 1.8 metres tall and the tree is 4 pencil lengths high, the height of the tree is 1.8 metres x 4 = 7.2 metres.
- 5) Now switch and have your partner repeat the measurement. Is his/her result very different from yours? Why might that be? Record both heights in your **Results** chart as **Height 1** and **Height 2**.

B) Without a partner: using proportions

You can calculate your tree’s height without a partner, as well. (Given that you have one or more partners, ask one of them to record the different measurements you take, then switch so they get a turn measuring the tree’s height as well.) Refer to the diagram below if you need help.

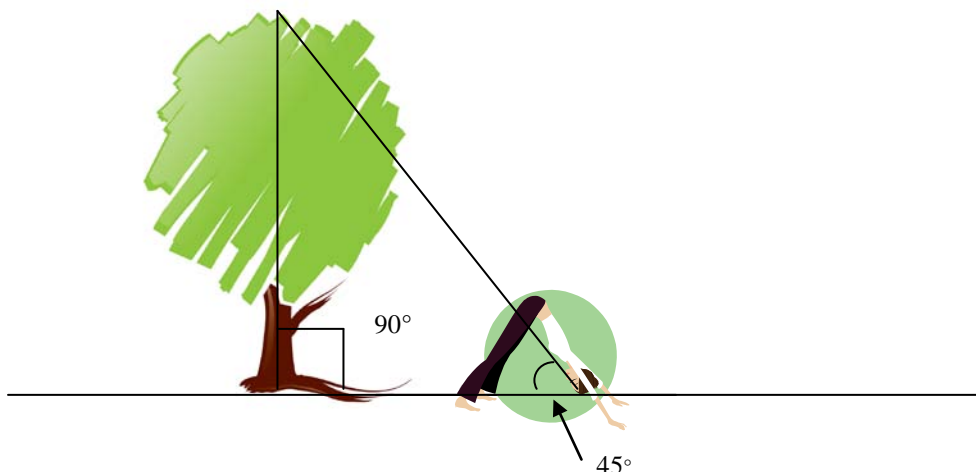
- 1) Walk away from the tree until you can easily see the base and top branches without moving your head. Hold the tape measure vertically at arm’s length (straight elbow) and position the tip at the top of the tree. Determine the distance from your eye to the tape measure in cm; you or your partner(s) can do this using the tape measure. This distance = ***d***. Record it in your **Results** chart.
- 2) Next, keeping the tip of the tape measure at the top of the tree, read the measurement where the bottom of the tape measure corresponds to the base of the tree. This measurement = ***h***. *h* is proportional to the height of the tree, which we’ll call ***H***. Note: it is important that you **DO NOT MOVE** your head or body when you read the measurements off the tape! Record *h* in your chart.
- 3) Using your tape measure, measure how far you are standing from the tree in metres. This measurement = ***D***, and it is proportional to *d* (measured in step 1). Record it in your chart.
- 4) Calculate the height of your tree: **$H = D \times h/d$** . Record H in your **Results** chart as **Height 3**.



C) Without a partner: using triangles

Native Americans used a different way to estimate the height of a tree; this method uses very little equipment, other than your body!

- 1) Walk away from your tree and find the place where, when you bend over and look through your legs, you can just see the top of the tree. This may take a few tries! Once you have found this spot, use your tape measure to measure the distance from where you are to the base of the tree in metres. Record it here: _____.
- 2) Next, look at the diagram below. Basically, for the average adult bending over to look through his/her legs, the angle that is formed looking up at the top of the tree is approximately 45 degrees. The angle formed where the tree trunk meets the ground is approximately 90 degrees if your tree is growing straight up.
- 3) This creates a right-angled triangle, where two angles are known. Calculate the third angle and record it here: _____. Based on what you know about triangles, you now have the information you need to estimate the height of the tree. Record it in metres in your **Results** chart as **Height 4**. Compare all of your heights. How similar are they? Discuss why they might vary.



Name(s): _____

RESULTS: Trees and Math

			Height using "height of a person" method		Height using proportions				Height using triangles
Common and Latin tree names	Circum- ference (m)	DBH* (m)	Height 1 (m)	Height 2 (m)	d (cm)	h (cm)	D (m)	Height 3 (m) H=D x h/d	Height 4 (m)

*DBH = diameter at breast height