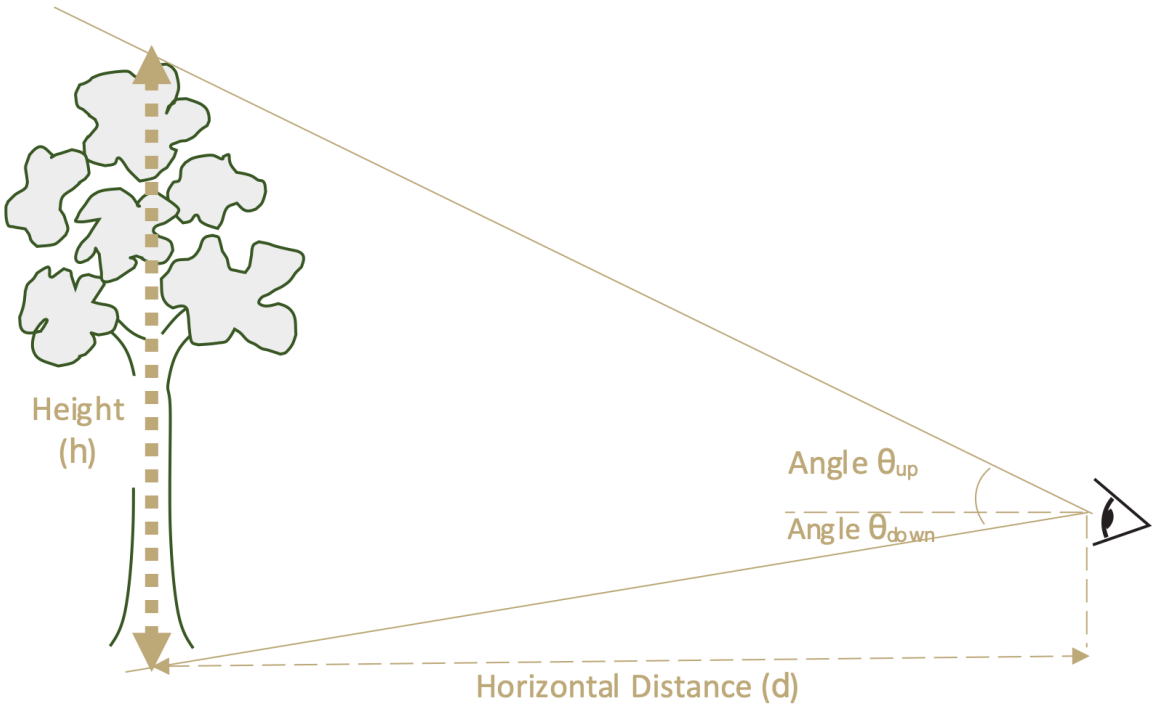
# Measuring Tree Height

Measuring tree height accurately can be difficult, so this is a guide to make it clearer what is required.

Tree height is the **height of the highest point of the tree crown above the ground**. It is not the height of the tree above the base of the tree, unless the tree is perfectly symmetrical and the highest point of the crown happens to be above the base of the tree. Understanding this distinction is important if you want to get an accurate measurement of the tree height.

It is rarely possible to reach the top of a tree to measure the height of it directly, so it is usually necessary to use some mathematics (trigonometry).

## Case 1 – Symmetrical Tree



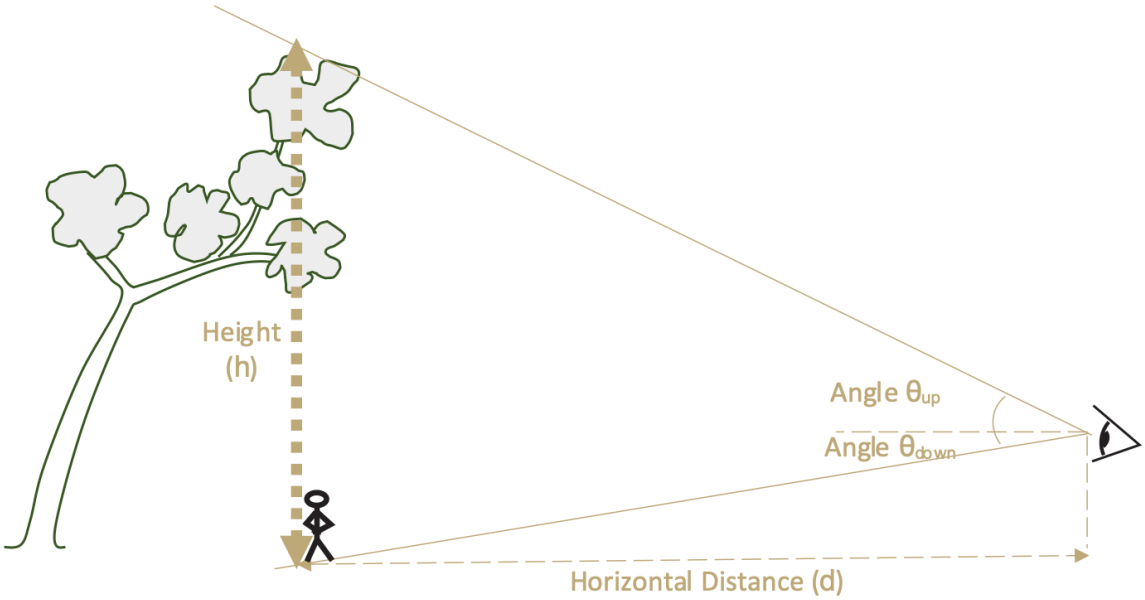

### Steps

1. Find a viewing position where you can see both the top and bottom of the tree, preferably at least one tree height away from the tree, or a little further.
2. Measure the horizontal distance (**d**) to the point vertically below the highest point of the tree, in this case it will be the base of the tree.
3. Measure the angle to the top of the tree ($\theta_{up}$) and to the point on the ground vertically below the top of the tree ($\theta_{down}$) using a clinometer app on a smartphone, or a specifically designed clinometer.

4. Calculate the tree height using trigonometry. Again you could do this using a scientific calculator on a smartphone. Height **(h) = d** * (tan $\theta_{up}$ + tan $\theta_{down}$) [Note: Don't add the angles together before taking the tan as this creates an error.]

If you don't have an instrument to measure the angle, you can use a diagonally folded piece of square paper. This will give you a 45 degree angle. Because tan 45 equals one, if you position yourself at a distance where looking along the top of the paper you line up with the top of the tree and at the same time the bottom of the paper lines up with the base of the tree, then, hey presto, your horizontal distance from the tree is approximately equal to the height of the tree.

# Case 2 – Asymmetrical Tree




## Steps

1. Find a viewing position where you can see both the top and bottom of the tree, preferably at least one tree height away from the tree, or a little further.

2. Measure the horizontal distance **(d)** to the point vertically below the highest point of the tree, in this case it will **not** be the base of the tree but some distance away. It might take a while to locate this point on the ground, but it is important to do so. It is helpful to have a second person to stand at this point so that you can measure both the horizontal distance and bottom angle to that person.

3. Measure the angle to the top of the tree ($\theta_{up}$) and to the point on the ground vertically below the top of the tree ($\theta_{down}$) using a clinometer app on a smartphone, or a specifically designed clinometer.

4. Calculate the tree height using trigonometry. Again you could do this using a scientific calculator on a smartphone. Height **(h) = d** * (tan $\theta_{up}$ + tan $\theta_{down}$) [Note: Don't add the angles together before taking the tan as this creates an error.]

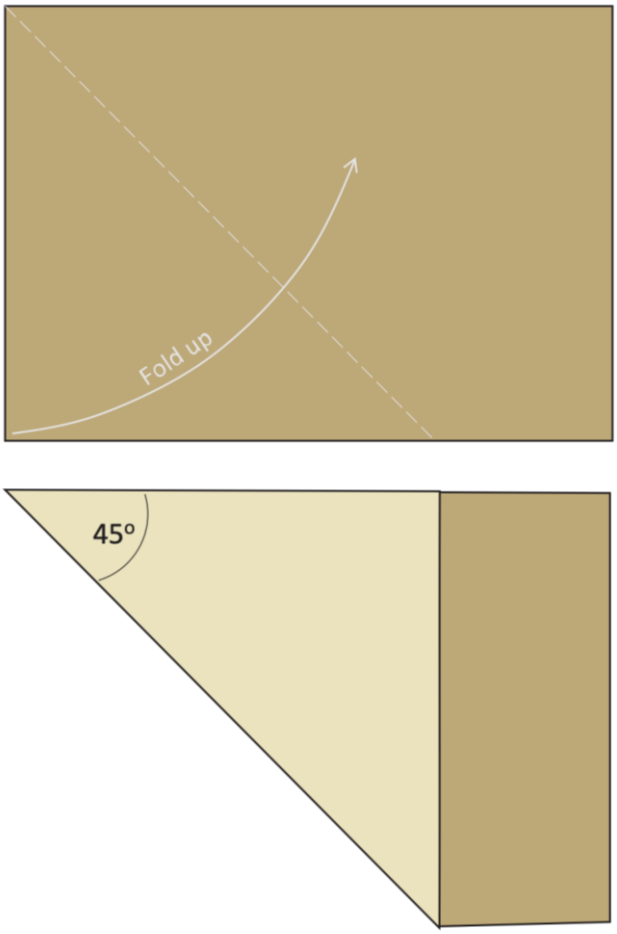
## Tips

- It is usually easier to do this with two people, one standing directly below the highest point of the tree and one taking the measurement.
- If the ground is sloping, it is usually easier to measure a tree looking downslope as this gives you a better view of the top of the tree.
- Measurement errors are least when you are one to two tree heights away from the tree, i.e. the angle measured is 45o or less.
- You may need to explore different directions from the tree to find which one gives you the best view of the top of the tree and the ground below it.
- If the canopy of the tree is rounded, make sure that you are far enough away to see the top of the tree, not just the closest edge of the canopy. Failing to do this will grossly over-estimate the tree height.

# Making a 45 degree paper protractor and measuring tree height

## Steps

1. Take a sheet of paper
2. Fold it on the diagonal so that the side perfectly aligns with the top of the paper (see diagram below). A square piece of paper is easier, but any rectangular piece of paper will do.
3. The resulting angle at the end of the diagonal will be 45 degrees.




Use by viewing the top of the tree along the diagonal edge and at the same time aligning the bottom of the 45o angle with the point on the ground vertically below the highest point of the tree. You need to move closer or further away from the tree until you get this exact alignment. Once this alignment has been found, measure the distance from your position to the point on the ground vertically below the highest point of the tree with a tape. This is the approximate tree height.