# $CO_2$ Carbon in a Tree (Option A) (1 of 3)

NAME: GROUP MEMBERS:

First, you will measure the circumference and height of at least one tree near your school. You will then use the data to calculate the amount of carbon stored in each tree.

## Measuring Tree Diameter

1. Use your measuring tape to measure the circumference of the tree. Be sure to measure the circumference approximately 1.4 meters (about 4.5 feet) above the ground. Record the circumference in centimeters in Data Table 1.

2. Next, use the equation $d = c \div \pi$ to calculate the diameter of the tree (where d = diameter; c = circumference; and $\pi = 3.14$). Record tree diameter in Data Table 1.

*Data Table 1*

| Tree | c circumference (cm) | d diameter (cm) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

## Measuring Tree Height

1. Stand far enough from the base of the tree to see the top. Measure the distance between you and the tree and record it in Data Table 2. Hold the protractor with the Tree End toward the tree and look through the straw. Find the top of the tree and have another group member read the angle at which the string crosses the protractor ($\theta_1$). Make sure your fingers are not blocking the string from moving freely. Record the angle in Data Table 2. To measure the angle to the bottom of the tree, look through the straw and find the base of the tree. Have a group member read the angle at which the string crosses the protractor ($\theta_2$). Record the angle in Data Table 2.

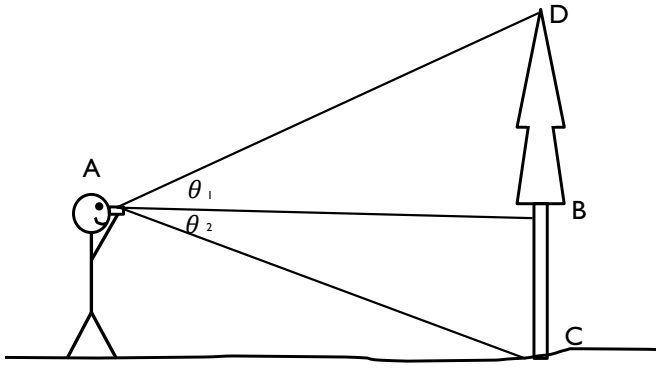
*Data Table 2*

| Tree | $\theta_1$ Angle to top of tree | $\theta_2$ Angle to base of tree | AB Distance from person to tree (m) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

Are you standing on a slope while using the clinometer? If your head is below the base of the tree or above the top of the tree, find a new tree to measure! The equation provided for calculating tree height cannot be used in these situations.

# $CO_2$ Carbon in a Tree (Option A) (2 of 3)

1. Next, use the following diagram and equations to calculate the height of each tree, noting that $\theta_1$ is the angle to the top of the tree and $\theta_2$ is the angle to the base of the tree. The tangent of the angle is expressed as tan. The distance between you and the tree is expressed as AB. Record your results in Data Table 3.




$\tan\theta_1 = \frac{DB}{AB}$ $\quad DB = AB \tan\theta_1$

$\tan\theta_2 = \frac{BC}{AB}$ $\quad BC = AB \tan\theta_2$

Total tree height = DB + BC = $AB(\tan\theta_1 + \tan\theta_2)$

*Data Table 3*

| **Tree** | $\tan\theta_1$ | $\tan\theta_2$ | $DB = AB(\tan\theta_1)$ | $BC = AB(\tan\theta_2)$ | Tree Height (h) in meters (m)<br>h = DB + BC<br>$h = AB(\tan\theta_1) + AB(\tan\theta_2)$ |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

## Calculating Carbon Storage (adapted from Trees for the Future, 2007)

1. *Calculating Green Weight (GW)*
   The green weight of a tree is an estimate of the mass of the tree when it is alive. This estimate includes all of the wood content and any moisture in the tree. Because the moisture in the tree can be up to hundreds of liters, the green weight can be quite large.

   As you can imagine, weighing a live tree and keeping it alive is not feasible! For this reason, foresters use a set of formulas to estimate green weight. These equations are based on real data—foresters cut and weighed trees and then analyzed the data to develop formulas to fit the data. The percentage of moisture in a tree varies by tree species; therefore, specific formulas have been developed for different tree species.

# $CO_2$ Carbon in a Tree (Option A) (3 of 3)

The equations used here are an "average" for trees in the Southeast and allow you to calculate the above-ground green weight of a tree based on the tree's diameter and height. To find the green weight, insert the values you obtained for diameter (cm) and height (m) into the appropriate equation and record your answers in kilograms (kg) in Data Table 4.

The constant in the equation accounts for the unit conversion between centimeters and meters; therefore, you do not need to first convert those measurement units to be the same.

For trees with diameter < 28cm: $GW = 0.0577 \times d^2 \times h$

For trees with diameter > 28cm: $GW = 0.0346 \times d^2 \times h$

2. *Calculating Dry Weight (DW)*

Dry weight represents the mass of the wood in the tree when dried in an oven so the moisture is removed. On average, experiments have shown that a tree's dry weight is about 50% of its green weight. Therefore, to find the dry weight, you just need to multiply green weight (GW) by 50%. Complete this equation for each tree you measured, and record your answers in Data Table 4.

$DW = GW \times 0.5$

3. *Calculating Carbon Storage (C)*

Carbon storage is the amount of carbon that is within the wood of the tree. This is the total amount of carbon that is captured from the atmosphere during photosynthesis as well as the amount of carbon sequestered by the tree. From experiments, scientists have found that about 50% of a tree's dry weight is carbon. To find carbon storage, multiply dry weight (DW) by 50%. Complete this equation for each tree you measured, and record your answers in Data Table 4.

$C = DW \times 0.5$

*Data Table 4*

| **Tree** | **Green Weight (GW, kg)**<br>d < 28cm: $GW = 0.0577 \times d^2 \times h$<br>d > 28cm: $GW = 0.0346 \times d^2 \times h$ | **Dry Weight (DW, kg)**<br>$DW = GW \times 0.5$ | **Carbon content (C, kg)**<br>$C = DW \times 0.5$ |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |