

Calculating Carbon

Essential Question: *Does the gas exchange between people and plants balance out?*

At a Glance:

Learners will better understand the connection between global warming and CO₂ emissions by quantifying actions and calculating.

Background Information

Trees and other plants make their own food. Nothing else on Earth can do this, and this is what makes plants producers of energy while almost all other organisms are consumers. In order to make their own food (in the form of glucose), plants need water and carbon dioxide. When water and carbon dioxide combine inside of a plant, glucose and oxygen are produced. Plants have little openings on the underside of their leaves through which carbon dioxide flows in and oxygen flows out.

Plants and people (and all the other creatures that breathe oxygen) need each other! Plants breathe in what we breathe out, and vice versa. Plants also breathe in what our cars breathe out and what planes, trains, wood fires, electric appliances, electronics add to the atmosphere as well. Just about everything, natural and manmade, adds carbon dioxide (CO₂) to the atmosphere in one way or another. CO₂ is a greenhouse gas. We have heard a lot about CO₂ lately because researchers have detected an increase in greenhouse gases, and this is thought to be contributing to global warming. CO₂ and other greenhouse gases make up the Earth's atmosphere. The atmosphere allows the sun's energy in. It allows some of the energy that bounces off the Earth's surface to escape back out into space, and it traps the rest, like a blanket. The Earth would be too cold for us to survive if there were no greenhouse gases.



However, in modern times humans have developed many inventions that have made our lives easier that unfortunately also put extra CO₂ into the atmosphere. Many researchers think that because of this extra CO₂, the Earth is getting warmer, ice is melting and sea levels are rising. Trees help to balance the level of CO₂. We need trees! And we also need to be more conscious of our output of CO₂, otherwise known as our carbon footprint.

How much CO₂ do we put out? And how much CO₂ can a tree take in? The actual numbers depend on the specifics of the activity, in the case of output, and the species of plant and environmental conditions, in the case of intake. The following activity is a very simple calculation to give Garden Earth Naturalists a rough idea of how it all balances. **This calculation is only a model. The numbers generated are not real numbers.**

Location: Outdoors

Objectives: *Learners will*

- 1) describe gas exchange in plants by estimate the CO₂ uptake of a tree.

Skills: data collection, observation, communication

Supplies:

- trees
- calculator
- pencil
- graph paper (optional)

Subjects: Science, math

Time: 15 minutes

Connections

Real calculations can be made by visiting the following websites:

www.americanforests.org/resources/ccc/

http://library.thinkquest.org/04oct/01865/ginv_calculator.htm

<http://svc237.bne113v.server-web.com/calculators/treecarboninfo.htm#GHGs>

<http://actonco2.direct.gov.uk/index.html>

Calculating the CO₂ Intake of a Tree

Start with one tree. (Introduce yourself to the tree.)

1. How big are the leaves of your tree - tiny, small, medium, large? (See diagrams.)
2. How many leaves does your tree have? (Estimate and choose from 20, 200, or 2000).
3. Measure air temperature. Choose between below or above 80 degrees F. (When it's really hot, trees may lose water when they open their stomates to get CO₂, so they may not take in as much CO₂ as on a day that's not so hot. When it's cooler, the rate of photosynthesis is lower, less CO₂ is needed by the plant, so less is taken in.)
4. Measure relative humidity. Choose one number that represents the range in which your measurement falls. (This is the amount of water vapor or water in gas form that is in the air. When it is more humid trees can conduct photosynthesis more efficiently and take in more CO₂. However, when it's really humid, trees reach their limit).
5. Fill in your boxes in the gray column.
6. Add gray boxes together and put sum in the last gray box.
7. Tell your tree, "Thank you!" (Give it a hug, if you like.)

HOW HIGH DOES YOUR TREE SCORE?		Choose one number for each block
Leaf size	tiny = 2 small = 5 medium = 10 large = 20	
Number of green leaves (estimated)	20 200 2000	
Air temperature	Below 60 degrees F = 5 Between 60 and 80 degrees F = 20 Above 80 degrees F = 10	
Relative humidity	10-49% = 10 50-69% = 30 70-100% = 50	
CO₂ intake score	Add up the gray column & put the answer in the last box.	

Calculating your Daily CO₂ Output

Believe it or not, just about everything we do is related to an output of carbon dioxide. Vehicles powered by gasoline and other fossil fuels add a lot of CO₂ to the air, as does any method of burning and fuel, such as wood or coal. Sometimes we emit CO₂ indirectly. For example, power plants that provide electricity for us burn fuel to get it to us in a form we can use. Products in stores are driven there in trucks and usually have required fuel-powered energy in their processing. Even the materials used in processing and packaging emitted CO₂ in their production. Realizing these things help us make positive choices for our environment.

Start by reviewing your actions so far in the day.

1. Put a number in the gray box for each activity that applies. (This is different from calculating the tree's score.)
2. Add all the numbers and put the sum in the last gray box.

HOW HIGH DO YOU SCORE?		Choose all that apply & put numbers in the box
Transportation	bike = 0 car = 50 (add 50 to your score for each car ride)	
Consumer choices	locally made = 0 USA made = 5 Made in another country = 100	
Energy use	turned lights off when not needed = -5 put on sweater instead of turning on heat = - 5 chose an unprocessed item = - 5 used electric lights = 500 used computer = 500 wore clothes that had been washed and dried in electric washer and dryer = 500 ate cooked food = 500 used heat or air conditioning = 500	
CO₂ output score	Add up the gray column & put the answer in the last box.	

To calculate a score for the relationship between you and your tree, subtract the tree's number from yours. This is the net amount of carbon put into the atmosphere by just you, just today. _____

Discussion/Assessment:

Discuss learners' carbon calculations.

What are some ways in which we can improve this number and reduce our carbon footprint? List these, make a chart, challenge your learners to improve their score and teach others about why this matters.

(Some examples are: plant a tree, ride bikes instead of driving when possible, turn out the lights when not in use, buy local products.)

Extensions:

- Choose a leaf, trace it on graph paper and count squares to determine the surface area. (Graph paper squares are usually 1mm squared.)
- Look at leaves under a microscope, especially the underside. Do you see any stomata? (Wandering Jew plants are good for this.) Discuss the function of a stomate and its surrounding guard cells with your learners. (*See Air Cleaning Department Take Home Packet for information.*)
- Look up weather information for your location and compare that to other geographical regions. Research and compare major plant types for two regions.