Name _____ Teacher _____ Date _____

Trees Made of Air

As we have seen, plants, including trees, take in carbon dioxide (CO_2) from the air and water (H_2O) and convert these molecules into sugar ($C_6H_{12}O_6$) and oxygen (O_2) molecules through the process of photosynthesis.

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

This means that trees can move CO_2 from the air into themselves.

- **How much CO_2 is sequestered (taken out of atmosphere) into a large tree?**
- **How does that compare with the amount of CO_2 we put into the air each year?**

These are the questions we will answer in this activity.

1. Explain how a solid tree can be produced from a gas (CO_2) and a liquid (H_2O).

2. The amount of CO_2 a tree can sequester depends on its size and many other factors. We are going to do a rough calculation tht depends only on the tree size, specifically the area covered by its canopy. The assumption is that the rate of photosynthesis, and therefore the rate of CO_2 uptake, depends on the amount of sunlight a tree captures. This, in turn, depends on the area of the canopy.

   Pick a tree in your school yard or neighborhood.
   - You will need a ball of string and a meter stick or measuring tape.
   - One partner should stand holding one end of the string at the edge of tree's canopy.
   - While unwinding the string, the other person should walk past the tree trunk to the edge of the canopy directly across from the first person.
   - Mark the edge of the canopy on the string.
   - Use the meter stick or measuring tape to measure the diameter of the canopy in centimeters.
   - Diameter of the canopy_____cm
   - Diameter of the canopy _____ m (diameter in cm x 0.01 m/cm)

3. Calculations
   Area of the canopy = πr^2. We want the area in m^2, so use the diameter in m.
   Therefore, area of the canopy A = 3.14 $[d/2]^2$ = _____ m^2
   The amount of carbon sequestered in the tree per year is:
   [1]A x 0.205 kg C yr^{-1} = _____kg C yr^{-1}

4. One of the ways we put CO_2 into the air is by driving. Through the process of combustion or burning, molecules of gasoline (composed of hydrocarbons such as C_8H_{18}) and oxygen (O_2)

---

[1] Nowak, DJ, Greenfield, EJ, Hoehn, RE, & Lapoint, E. (2013). Environmental Pollution 178, 229-236.

Carbon TIME

Plants Unit, Community Connection Activity
Carbon: Transformations in Matter and Energy 2017
Michigan State University

are converted into molecules of CO_2 and, H_2O, both of which are emitted into the air and move into the atmosphere.

$$2 \, C_8H_{18} + 25 \, O_2 \rightarrow 16 \, CO_2 + 18 \, H_2O$$
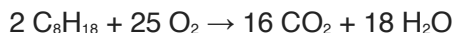
The Environmental Protection Agency (EPA) estimates **a typical passenger vehicle emits about 4.7 metric tons (1000 kg) of carbon dioxide per year. That is 1300 kg of carbon moving from gasoline to the atmosphere per year.** This assumes the average gasoline vehicle on the road today has a fuel economy of about 21.6 miles per gallon and drives around 11,400 miles per year. Every gallon of gasoline burned creates about 8.9 kg of CO_2.

Does your tree sequester 1300 kg of carbon per year? _____

How many trees like yours would it take to sequester 1300 kg of carbon per year?

Digging Deeper

1. Our calculation of the amount of carbon dioxide sequestered per yea depended on the size of the canopy of the tree. However, in reality there many *other factors that affect the rate of photosynthesis*. Can you think of some of these?

   The U.S. Department of Agriculture Forest Service has a calculator that takes into account type of tree and climate (CUFR Tre Carbon Calculator, https://www.fs.usda.gov/ccrc/tools/tree-carbon-calculator-ctcc). This calculator uses the diameter at chest height and the height of the tree as measures of tree size. *How does the estimate of CO_2 sequestered from this tool agree with your original calculation?* Note that your original calculation yielded kg of carbon and this calculator estimates kg of carbon dioxide. To compare the results, you need to know that carbon makes up a little more than a quarter (0.27) of the mass of carbon dioxide.

2. You calculated the amount of carbon your tree sequesters in a year. But *how much carbon does the tree sequester over its life time*? The Forest Service calculator also gives this information.

   total kg CO_2 sequestered x 0.27 = total kg carbon

   What do you think will be the fate of that carbon? What happens to the carbon in each of the following scenarios?

- The tree is harvested and used for firewood.

- The tree is harvested and its wood is used to make a house.

- The tree dies and decomposes in the forest.