Student Activity 5—Sheet 2

How Much Carbon Is in That Tree?

Part 1: Calculating the Height of the Tree

1. Select a tree. Find a location from which the observer can see the top and the base of the tree. Using a measuring tape, measure the horizontal distance to the tree from this spot.

2. The observer uses a clinometer or level app on a smartphone to measure the angle of elevation of the top of the tree and the angle of depression of the base of the tree.

3. Record the three measurements from questions 1 and 2 on the diagram on the right.

4. Calculate the height of the tree. Round your answer to the nearest tenth of a metre.

Part 2: Calculating the Size of the Tree

The shape of a tree changes with its height. Most of the mass of the tree is in its trunk, but some is in its branches and roots. To approximate the volume of a tree, we will treat it as a cylinder. The volume of a cylinder is given by the formula V  πr2h.

A tree trunk tapers, so measuring its circumference at the bottom will give a value that is too big. By convention, foresters use the circumference measured 1.30 m above the ground to provide a good approximation of the radius of the trunk (the cylinder).

1. Measure the circumference of the tree trunk in centimetres at a height of 1.30 m up the trunk. (Note: Round to the nearest centimetre.)

C 

2. Calculate the radius of the trunk of the tree at this height. Remember that C  2πr, where C is the circumference in centimetres, r is the radius in centimetres, and π is about 3.14. (You’ll need to rearrange this equation.)

r 

3. Express your result in metres. Round your answer to two decimal places.

r 

Part 3: Calculating the Mass of Carbon Dioxide Trapped by the Tree

1. Calculate V, the volume of the tree (in cubic metres, m3) using the formula V  πr2h, where r is the radius in metres, h is the height of the tree in metres, and π is about 3.14.

V 

2. Calculate the mass of the tree (in kilograms) using the following densities for wood:
• hardwood (e.g., oak, maple, poplar) is about 700 kg/m3
• softwood (e.g., pine, cedar) is about 400 kg/m3

mass 

Since about 20% of a tree’s mass is in its roots, multiply your result by 1.25 to better approximate the mass:

mass 

3. About 65% of a tree is solid matter, and about 50% of the solid matter is carbon. Calculate the mass of carbon in the tree (in kilograms) using the equation

mass of carbon  mass × 0.65 × 0.50
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4. Finally, carbon has an atomic mass of 12 u. When one carbon atom is combined with two oxygen atoms (each with an atomic mass of 16 u), the carbon dioxide molecule has a mass of 12 u  (16 u × 2) or 44 u. Thus, the mass of carbon dioxide captured is actually $\frac{44 u}{12 u} $or about 3.67 times the mass of carbon in the tree:

mass of CO2 trapped  mass of carbon × 3.67


Part 4: My Yearly Carbon Dioxide Footprint

Let’s estimate how much carbon dioxide you produce in a year.

A: Breathing

Just breathing, you produce about 1 kg of carbon dioxide each day.

365 kg of CO2/year (A)

B: My Trip to School

Transportation is a major source of carbon dioxide.

Round-trip distance from your home to the school and back to your home is \_\_\_\_\_\_\_ km.

Choose one of the modes of transportation and enter the distance from above.

|  | Annual Carbon Dioxide Contribution Based on Method of Transportation and the Distance Between School and Your Home | Annual Carbon Dioxide Contribution Due to Transportation |
| --- | --- | --- |
| Car | \_\_\_\_\_\_ km × 47.7 kg of CO2/km  | \_\_\_\_\_ kg of CO2 (B) |
| Bus | \_\_\_\_\_\_ km × 5.24 kg of CO2/km  |
| Bicycle | \_\_\_\_\_\_ km × 0.00 kg of CO2/km  |
| Walking | \_\_\_\_\_\_ km × 0.00 kg of CO2/km  |

C: Electricity

Burning fossil fuels to produce electricity is a major source of carbon dioxide.

Electricity Use from Technologies

|  | # of Hours Actively on per Day (h) | Annual Carbon Dioxide Contribution Based on Power Consumption and Efficiency of Electricity Generation | Total Annual Carbon Dioxide Contribution Due to Technology |
| --- | --- | --- | --- |
| Television |  | × 1.50 kg of CO2/hour \_\_\_\_\_\_ kg of CO2 (C1) | (C1)  (C2)  (C3) \_\_\_\_\_ kg of CO2 (C) |
| Desktop computer |  | × 12.3 kg of CO2/hour \_\_\_\_\_\_ kg of CO2 (C2) |
| Laptop computer |  | × 4.90 kg of CO2/hour \_\_\_\_\_\_ kg of CO2 (C3) |

D: Electricity Used to Heat Water

|  | # of Showers/Baths per Week | Annual Carbon Dioxide Contribution Based on Amount of Water Used and Water Heater Efficiency | Annual Carbon Dioxide Contribution Due to Heating Water |
| --- | --- | --- | --- |
| Showers |  | × 30.2 kg of CO2/shower \_\_\_\_\_\_ kg of CO2 (D1) | (D1)  (D2) \_\_\_\_\_ kg of CO2 (D) |
| Baths |  | × 58.5 kg of CO2/bath \_\_\_\_\_\_ kg of CO2 (D2) |

E: Electricity Used for Lighting

Estimate the number of light bulbs in your own room.

|  | # of Hours Actively on per Day (h) | # of Hours for Each Type of Light Bulb | Annual Carbon Dioxide Contribution Based on Power Consumption of Type of Light Bulb | Annual Carbon Dioxide Contribution Due to Lighting |
| --- | --- | --- | --- | --- |
| Regular light bulbs |  | × \_\_\_ bulbs \_\_\_ hours | × 4.9 kg of CO2/hour \_\_\_\_\_ kg of CO2 (E1) | (E1)  (E2) \_\_\_\_\_ kg of CO2 (E) |
| Energy-efficient light bulbs |  | × \_\_\_ bulbs \_\_\_ hours | × 0.7 kg of CO2/hour \_\_\_\_\_ kg of CO2 (E2) |

Estimate of My Annual Carbon Dioxide Footprint

(A)  (B)  (C)  (D)  (E)  \_\_\_\_\_\_\_\_\_\_\_\_\_ kg of CO2

Consolidate Your Learning

Answer the following questions to check your understanding of concepts relating to your carbon footprint.

1. The average Canadian has a carbon dioxide footprint of about 20 000 kg of carbon dioxide each year! How many of your trees would be needed to represent this amount of carbon dioxide?

2. If you wanted to do a more complete analysis of your carbon dioxide footprint, what other sources of greenhouse gases should you include?

3. In Canada, an acre of mature trees can store the equivalent of 2600 kg of carbon dioxide per year. How many acres of trees would be needed to offset your carbon dioxide footprint?

4. How does your electricity use add carbon dioxide to the environment?

5. Storing carbon dioxide is one approach to the problem of greenhouse gases. Another is to reduce the amount produced. Emerging technologies can help. Rooftop solar panels can generate electricity for a household when it needs it and channel any unused electricity back into the grid.

(a) A typical rooftop installation of solar panels produces about 3360 kWh of electricity per year and the average home uses about 972 kWh per month. What percent of the household’s electricity use would this installation supply?

(b) Electricity generation in Ontario creates about 0.053 kg of carbon dioxide per kilowatt hour (kWh). How many kilograms of carbon dioxide would this solar panel installation keep from being produced each year?

(c) Why would it be difficult to supply a home’s electricity needs with solar panels?