ARM

CLIMATE RESEARCH FACILITY

Education and Outreach Lesson Plan

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Grade levels 3–5

Planting Trees

Approximate Time

One to three hours, depending upon amount of teacher modeling and depth required in written portion of worksheets. Can be a one-day or several-day investigation.

Objective

The objective is to estimate the number of trees to be planted per year as a carbon sink to compensate for one year's use of four types of cars.

Key Points to Understand

Human activities, such as driving a car, using a hot tub, or taking a trip by airplane all leave a carbon footprint. It will be interesting to calculate the number of trees you would need to plant in order to absorb the carbon dioxide from a single car over a year. The carbon footprint is a very powerful tool to understand the impact of personal behavior on global warming. Most people are shocked when they see the amount of carbon dioxide, or CO2, their activities create!

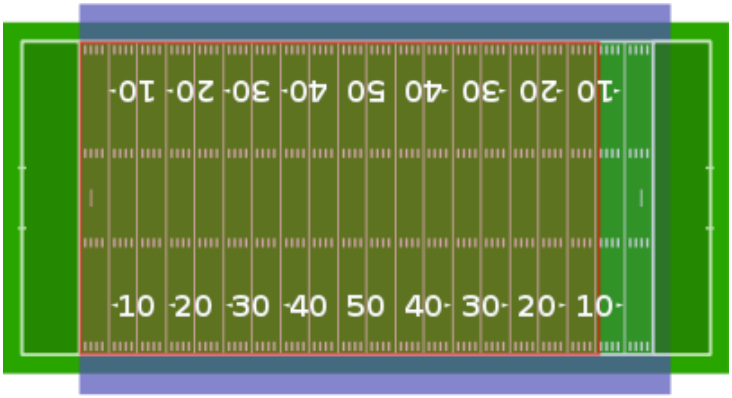
- We need to know the approximate distance traveled by the average American car in a year: 15,000 miles or 24,225 kilometers.
- We also need to know the approximate number of gallons/liters of fuel consumed in order to travel this distance. If you know how much fuel your car uses, such as 28 miles per gallon/11.9 kilometers per liter, you may simply convert the distance traveled to gallons or liters of fuel used.
- If you don't know exactly how much fuel your car uses, you can use these averages:
  - SUV: 18.5 miles per gallon
  - Light-duty truck: 25.1 miles per gallon
  - New fuel-efficient car: 33.7 miles per gallon
  - Average American car (all vehicles currently in use): 23.8 miles per gallon
- You need to know that each gallon of gasoline used by a car releases 8.7 kilograms of carbon dioxide, or 1 liter releases 2.36 kg of carbon dioxide. S**imply put, one gallon of gas emits 20 pounds of CO_2.**
- It has been estimated that about 2.5 acres/1 hectare of growing trees (1,000 trees) takes up about 20,000 kilograms of carbon dioxide each year. In other words, 1,000 trees will provide a carbon sink for 20,000 kilograms of CO_2.
- **Therefore, one tree during the period of one year will provide a carbon sink for 20 pounds of CO_2.** This is the formula we will use to convert the use of gas for our vehicles into the number of trees needed:

One tree X one year = 20 pounds CO2 absorbed.

Carbon emissions for types of fuels and unit (standard and metric)

fuel type	unit	CO2 emitted per unit
Gasoline	1 gallon (USA)	8.7 kg
Gasoline	1 liter	2.3 kg
Diesel	1 gallon (USA)	9.95 kg
Diesel	1 liter	2.7 kg

Key Vocabulary



- **Acre:** The easiest way to visualize an acre is as a rectangle measuring 88 yards by 55 yards, approximately the size of a standard American football field without the end zones.

- **Carbon footprint:** A **carbon footprint** is a measure of the impact our activities have on the environment. It relates to the amount of greenhouse gases produced in our day-to-day lives through burning fossil fuels for uses such as electricity, heating, and transportation. The carbon footprint is a measurement of all greenhouse gases we individually produce and is measured in units of tons (or kilograms) of carbon dioxide equivalent. In other words, when you drive a car, the engine burns fuel, which creates a certain amount of CO_2, depending on its fuel consumption and the driving distance. When you heat your house with oil, gas, or coal, then you also generate CO_2. Even if you heat your house with electricity, the generation of the electrical power may also have emitted a certain amount of CO2. When you buy food and goods, the production of the food and goods purchased also emitted some quantities of CO2.

- **Carbon dioxide:** CO_2 is the chemical symbol for carbon dioxide, a greenhouse gas.

- **Carbon source:** A carbon source is anything that releases more carbon than it absorbed.

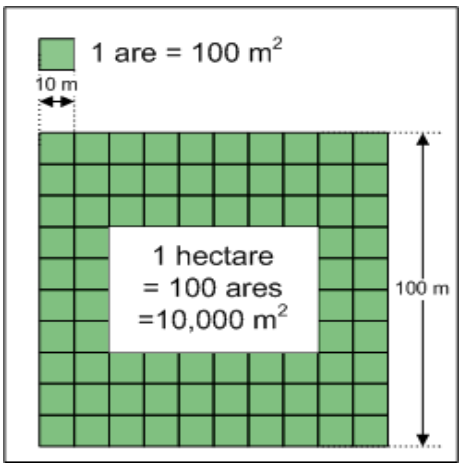
- **Carbon sink:** A carbon sink is anything that absorbs more carbon than it releases. Forests, soils, oceans, and the atmosphere all store carbon, and this carbon moves between them in a continuous cycle. This constant movement of carbon means that forests act as sources or sinks at different times.

- **Liter:** A metric measure of liquid volume**,** 1000 milliliters or 3.79 liters per gallon.

- **Gallon:** A standard measure of liquid volume, equal to 3.79 liters.

- **Greenhouse Gases:** Greenhouse gases are atmospheric gases that trap energy emitted from the Earth, lower atmosphere, or clouds or aerosols and, as a result, enhance global warming. Many of these gases are naturally occurring and are essential to life on Earth by providing a blanket for marine and terrestrial organisms. Without them, temperatures on Earth would be intolerably cold. However, when their concentrations become too high, they may contribute to global warming to such an extent that they would make the Earth intolerably hot.

- **Hectare:** A unit of area defined as 10,000 square meters, or about 2 ½ acres (two full American football fields). One hectare = 107,639.104 square feet.



- **Kilometer:** One thousand meters, or about 5/8 of a mile.

- **Mile:** 5,280 feet or 1.6 kilometers.

- **MPG**: miles per gallon.

Materials

- Paper for calculations
- Pencil or pen
- Calculator
- Worksheets
- Colored pencils for shading in bar graph

Preparation

Be sure that all materials are either centrally located or are already distributed to student groups. Check calculators to be sure they are working properly. If used as a whole-class activity, prepare poster paper or document camera for presentation and input of data and student questions. You will need to find a picture of the four types of vehicles to be investigated for carbon footprint: SUV, light-duty truck, new fuel-efficient car, and an older model car.

Management Tip

Students may need to fill in student response sheets as directed by the teacher dependent upon student needs. Worksheet can be modeled under a document camera or can be enlarged to poster size to be completed as a whole class guided activity or as an individual or team-task activity.

Procedure

1. Ask students: How many trees will it take to soak up the amount of carbon dioxide created by one average car driven for a year? Write responses/predictions on butcher paper to compare with student thoughts after the experiment.

2. Read the background information to students or make a chart with the important background points. Draw or show the formula indicating one tree X one year = 20 pounds CO2 absorbed.

3. Focus the students by explaining the following:

In the information we are about to investigate, we will discover the number of trees it takes to soak up the amount of carbon dioxide waste, or the carbon footprint, that four common types of vehicles create in one year of use. This "soaking up" of carbon dioxide is called a carbon sink. We will then be able to determine which types of cars are best for our environment based on their carbon footprint. Display the pictures of the four vehicles investigated.

4. Begin lesson using worksheets: Either guide students by modeling the enclosed pages (see management idea), or if students are developmentally able, allow them to independently fill in worksheets starting with the data chart, then graphing to the bar graph, and culminating with the related illustration and questions. (This lesson plan packet contains assessment, art strand, synthesis and analysis strands, and a writing component.) Have students use a different colored pencil per vehicle on the bar graph to further highlight the difference in number of trees.

5. Revisit student predictions regarding number of trees needed as a carbon sink. (See questions below.)

Questions

- How many trees will it take as a carbon sink for each type of vehicle?
- Which vehicle is the best for the environment based on its carbon footprint?
- How close were you on your prediction of the number of trees needed as a carbon sink for a vehicle driven for a year? Were you close or far away? Were you surprised by the number needed? Why or why not?

Closure and Evaluation

Students will complete several worksheets, including data table, graph, and several questions. The above questions may be used as a class discussion or for individual assessment after the investigation.

Suggested Follow-Up Activities:

- Collect current newspaper articles regarding increases or decreases in rainfall. Discuss with the class.
- Study of stream table.
- Study of rainfall in the state and how it is affected by geographical features.
- Graph rainfall using data from the newspaper for several weeks and compare/contrast data.

Suggested Follow-Up Activities

1. Using what you learned on this activity, create a brochure that advertises the ideal car you feel causes the least carbon impact. Use a tri-fold brochure, providing the name of the car, a picture, its average MPG, the total gallons used in a year based upon 15,000 miles driven per year, the CO_2 output, and your sales pitch as to why this is a great car to purchase.
2. Research what auto makers are planning for future MPG for the next generation of cars to be manufactured. How does it differ from the current MPG average? (Hint: In July 2011, President Obama outlined a plan to raise fuel efficiency and cut harmful carbon pollution for model year 2017–2025 cars and light-duty trucks. The plan sets a fleet-wide average standard of 54.5 miles per gallon by 2025.)
3. Research hybrid car technology. What is a hybrid car? How does it affect the carbon footprint? What is the average MPG of a hybrid? Are there any advantages to buying one?
4. How do electric cars figure in the overall carbon footprint? Who makes them? What carbon impact do they have compared to a gasoline-powered or hybrid car?
5. Visit a local car dealership and investigate firsthand the types of cars for sale and their fuel efficiency and carbon footprint. Interview a salesman and ask about what they have seen over the course of their career with regards to gas mileage trends in automobiles.
6. Use the information from the work sheet you used to calculate the number of trees needed as a carbon sink to offset the number of trees of your most used family vehicle. You will have to ask your parents what the MPG is for that vehicle and the average miles driven per year for that vehicle.

Name_____
Date_____

Planting Trees

Research Question: How many trees are needed as a carbon sink to overcome the carbon output of the average American car for one year? For a new fuel-efficient car? For a light-duty truck? For an SUV?

Hypothesis

_____
_____
_____
_____

Materials

- Paper
- Pencil and pen
- Calculator
- Colored pencils

Data

Trees Needed as a Carbon Sink

Vehicle	**Avg Miles Driven**	**Avg MPG**	**Gallons consumed in 1 year** (Miles divided by MPG)	**CO_2 emitted, pounds** (Gallons multiplied by 20)	**Trees needed** (Pounds of CO_2 divided by 20)	**Square Feet needed for Total Trees Needed** (See formula below)	**Rank: Most friendly to the environment 1 to 4 1 = highest**
Average US car (all years)	15,000	23.8					
New car (2011)	15,000	33.7					
Light duty truck	15,000	25.1					
SUV	15,000	18.5					

1000 trees= 1 Hectare/2.5 acres = 107,639.104 square feet

Graph the data from the Trees Needed as a Carbon Sink table.

Bar graph:

Trees Needed for Carbon Sink

No. of Trees	Ave Car	New Car	Truck	SUV
50,000				
45,000				
40,000				
35,000				
30,000				
25,000				
20,000				
15,000				
10,000				
5,000				
0				

Vehicle

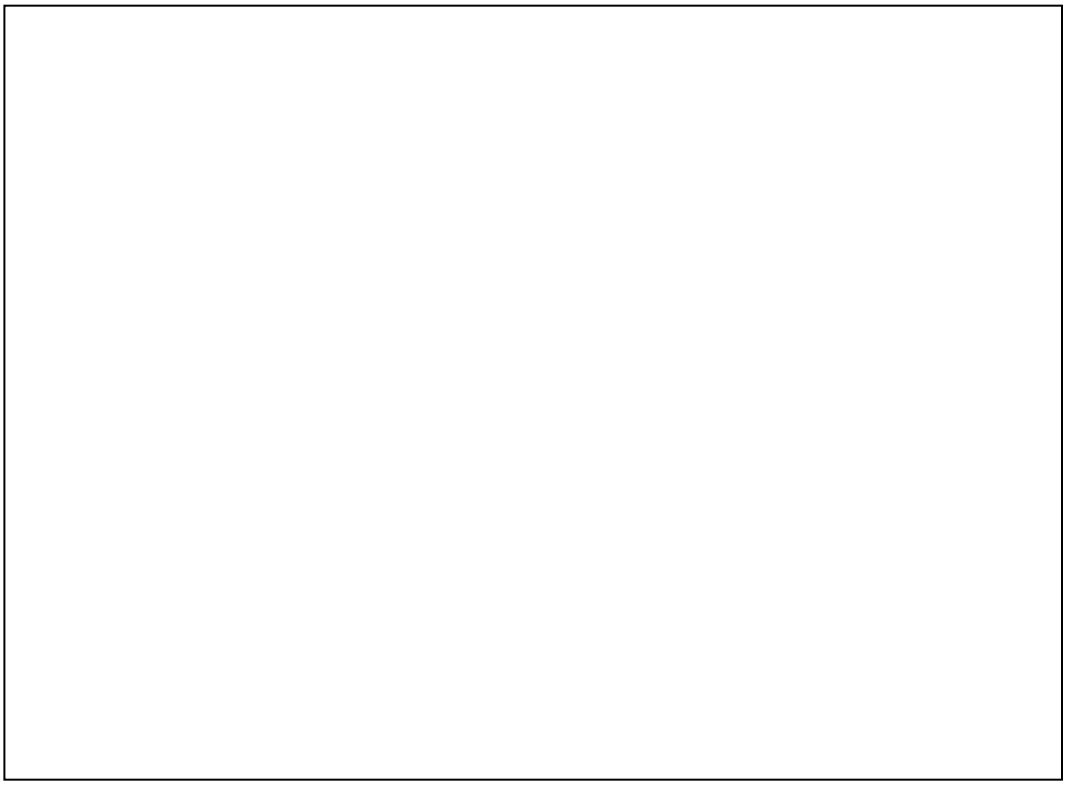
The following graph can be used to direct students to independently fill in their own bar graph: Include: Title, Labels for each axis (X axis = objects graphed), Y axis = units graphed), Scale, and Key.

Conclusion

Based on your hypothesis, recorded data, and findings from the experiment, write a conclusion.

_____
_____
_____
_____
_____
_____
_____

Draw a tree that you think might be a good carbon sink. Name the type of tree and use labels for the parts of the tree.



Answer the following questions using the data collected:

1. Which vehicle used the most trees to compensate for its carbon output?

_____
_____
_____
_____

2. a) Why do you think the planting of trees is important?

_____
_____
_____
_____

b) Now look at the table you completed on worksheet page 2. Using the trees needed column, change the number of trees needed into acres and then into hectares needed to grow the trees needed for as a carbon sink for each vehicle investigated. Put your findings in the chart below:

Use this formula:
1000 trees= 1 Hectare/ 2.5 acres

Average US car (all years)	Acres:	Hectares:
New car (2011)	Acres:	Hectares:
Light-duty truck	Acres:	Hectares:
SUV	Acres:	Hectares:

3. If your family were to buy a car to drive for a year, which one would you buy and why would you encourage your family to buy this vehicle? (an older car, a new car, a light-duty truck, SUV)

_____
_____
_____
_____