

Are You Meeting the Kyoto Protocol Calculating Your Carbon Dioxide Footprint

OBJECTIVE

Students will calculate their yearly CO₂ emissions and compare their results with the amounts listed in the international Kyoto Agreement on greenhouse gases.

LEVEL

Middle Grades: Earth Science

NATIONAL STANDARDS

UPC.2, UPC3, A.1, A.2, B.3, D.2, F.4, F.5

TEKS

6.2(C), 6.2(D), 6.2(E)

7.2(C), 7.2(D), 6.2(E)

8.2(C), 8.2(D), 8.2(E), 8.6(C), 8.12(C), 8.14(C)

IPC 1(A), 2(A), 2(C), 2(D), 8(A), 8(E), 9(A), 9(B), 9(C)

CONNECTIONS TO AP

AP Environmental Science:

IV Environmental Quality A. Air/Water/Soil 1. major pollutants

V Global Changes and Their Consequences A. First-order Effects 1. atmosphere B. Higher-order Interactions 1. atmosphere

TIME FRAME

45 minutes

MATERIALS

Calculators, Global Warming Wheel Card

TEACHER NOTES

Calculation Your Carbon Dioxide Footprint has students explore how human activity has resulted in changing the composition of the atmosphere. The lab may be done when studying the atmosphere, energy sources or environmental changes.

Environmental scientists call the amount of anything you produce into the environment your “footprint”. In this lab students will be specifically calculating the amount of carbon dioxide they are emitting into the atmosphere and therefore calculating their CO₂ footprint. Other footprint labs might have students calculate their solid waste footprint, waste water footprint, methane footprint or even a combination of all categories just called their “environmental footprint”.

The Kyoto Protocol was developed by the United Nations Framework Convention on Climate Change and was adopted by the United Nations in December of 1997. The protocol brought an international focus to limiting the emission of greenhouse gases and specifically focused on carbon dioxide, methane, and nitrous oxides. While 84 nations, including the US, have signed the treaty, not all nations have ratified it, which would require nations to enforce it. The Kyoto Protocol has different recommendations for developed vs. developing countries and only recommends limiting emissions for the 38 nations with the highest emissions. Thirty-one of the high-emission nations have ratified it and are making efforts to reduce their emissions. The US is one of the seven countries that has signed the protocol but not put any limits in place. Even for countries complying with the Kyoto Protocol, it is not a binding contract, and countries police themselves.

A copy of the Protocol is available at: <http://unfccc.int/resource/docs/convkp/kpeng.html>

Prior to doing this activity in class, give your students the homework assignment to talk to their parents and research their household amounts of heating cost (natural gas or heating oil), electricity cost, miles traveled and recycling (the listed categories of carbon dioxide production from the student answer sheet). The students will bring this data to class to calculate their carbon dioxide emissions.

Each group will need a Global Warming Wheel Card, available at:

[HTTP://YOSEMITE.EPA.GOV/OAR/GLOBALWARMING.NSF/UNIQUEKEYLOOKUP/SHSU5BWJQ7/\\$FILE/WHEELCARD.PDF](HTTP://YOSEMITE.EPA.GOV/OAR/GLOBALWARMING.NSF/UNIQUEKEYLOOKUP/SHSU5BWJQ7/$FILE/WHEELCARD.PDF)

You will need to print these and put them together prior to class. The finished cards will look like this:

POSSIBLE ANSWERS TO THE CONCLUSION QUESTION AND SAMPLE DATA

DATA – WHAT'S YOUR SCORE

Category	Your Estimated Household Amount	Pounds of CO ₂ Emitted Per Year
Waste Disposal	recycle half	3,900
Transportation	400 miles	23,600
Home Heating/Water Heating	\$25	6,000
Electricity Use	\$120	29,500

ANALYSIS – WHAT'S YOUR SCORE

YEARLY HOUSEHOLD TOTAL (LBS. OF CO ₂)	NUMBER OF PEOPLE IN HOUSEHOLD	YOUR INDIVIDUAL TOTAL (LBS. OF CO ₂)
63,000	3	21,000

DATA – WHAT CAN YOU DO?

Category	Actions You Can Take	Pounds of CO ₂ Saved Per Year
Waste Disposal	Reduce waste by 10%	1,200
Transportation	Improve mileage by 10 miles per gallon and cut driving 25 miles per week	8,500
Home Heating/Water Heating	Turn thermostat down 10 degrees Fahrenheit each night	250
Electricity Use	Replace 60-watt incandescent bulbs with 13-watt fluorescent bulbs	1,500

ANALYSIS – WHAT CAN YOU DO?

TOTAL SAVED (LBS. OF CO ₂)	NUMBER OF PEOPLE IN HOUSEHOLD	YOUR INDIVIDUAL AMOUNT SAVED (LBS. OF CO ₂)
11,450	3	3,817

CONCLUSION QUESTIONS

1. How does your individual total compare to the total carbon dioxide emissions recommended by the Kyoto Protocol?
 - Answers will vary.
 - For the sample data, the total was twice the recommended amount.
2. What category produced the most CO₂ in your household? List ways you could reduce this total.
 - Answers will vary. Transportation was by far the largest category. Students might suggest taking the bus, walking, carpooling or arranging to take fewer trips by car. We also could buy a car with better gas mileage or a hybrid that gets great gas mileage.

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3. How much were you able to reduce your emissions by making the changes recommended by *What Can You Do?*
 - In the sample data, almost 4,000 pounds or 2 tons. This is still above the Kyoto recommended amounts, but that is a great improvement.
4. Individuals in the developing countries produce much less CO₂ than individuals in the United States. Why is this true?
 - They use less energy because they have fewer cars and less money for expensive house heating and cooling systems.
5. If the answer to question number four is true, why is it still important for developing countries to work on reducing emissions?
 - Population is growing more rapidly in developing countries and the more people a country has, the more emissions they produce. Also, developing countries have more forest to clear for agriculture.
6. The United States has signed the Kyoto Protocol, but does not follow or enforce the agreement. What recommendations would you make to the government about this treaty? Should it be modified for the United States?
 - Answers will vary. The US government has concerns that the Kyoto Protocol would adversely effect the economy. There are many aspects to reducing emissions that would not effect the economy, especially those focused on individuals making changes in their day to day energy use. It is not necessary to modify the protocol, as the amounts are **goals** to be met by countries and there is no enforcement arm. Having a low amount as a goal is a good thing. The Kyoto Protocol is already modified for the developed countries.
7. In your opinion, is there any hope for something like the Kyoto Protocol, or will countries of the world never be able to reach such accords?

- Yes, the Montreal Protocol, which was drafted to address the destruction of ozone in Earth's atmosphere by CFC's, has been very successful in reducing the use of CFC's. In contrast to the Kyoto Protocol, the Montreal Protocol was ratified and enforced by the ratifying nations, leading to a reduction in CFC releases to the atmosphere. Projections are that this will lead to a reduction of the hole in the ozone layer. So, while the Montreal Protocol provides a reason for optimism in regard to question 7, there are some key differences between the two issues. Students should compare the relative impacts on a nation's economic infrastructure between 1) replacing one manufactured chemical compound used for aerosol products and refrigerants with another manufactured chemical compound (i.e., result of Montreal protocol) and 2) replacing one form of energy (e.g., fossil fuels) with another (e.g., electric/hybrid vehicles, hydrogen cells, solar, wind and other alternative energies).

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The Kyoto Protocol is an international agreement written by the United Nations Framework Convention on Climate Change to limit or reduce the emission of greenhouse gases. Carbon dioxide is one of the gases which is addressed by this Protocol. The recommended amount of carbon dioxide emissions per person is 5.5 tons per year (1 ton = 2000 pounds) How much carbon dioxide do you produce a year? Can you reduce that number?

PURPOSE

Students will calculate the amount of carbon dioxide they contribute to the atmosphere every year.

MATERIALS

calculators

PROCEDURE

Part I – What's Your Score?

1. Make a hypothesis about the amount of CO₂ you produce a year.
2. Use the global warming wheel and the information you gathered for homework to fill in the data table on the student answer page.
3. In the Part I analysis section of your student answer page calculate your family's total pounds of CO₂ emitted. To adjust this number to reflect the amount of CO₂ you as an individual produce, divide the total emissions by the number of people in your household. Record this value in the appropriate box on the analysis table.

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Part II – What Can You Do?

4. Use the global warming wheel to complete the Part II data table.
5. Calculate your family's total CO₂ savings and record it in the Part II analysis table. Divide by the number of people who live in your family to get your individual savings.
6. Use the data you collected and the information on this page to answer the conclusion questions on your student answer page.

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HYPOTHESIS

PART I – WHAT’S YOUR SCORE?

DATA – WHAT’S YOUR SCORE

Category	Your Estimated Household Amount	Pounds of CO ₂ Emitted Per Year
Waste Disposal (percentage of waste you recycle)	%	
Transportation (miles per week)	miles	
Home Heating/Water Heating (\$ per month)	\$	
Electricity Use (\$ per month)	\$	

ANALYSIS – WHAT’S YOUR SCORE

YEARLY HOUSEHOLD TOTAL (LBS. OF CO ₂)	NUMBER OF PEOPLE IN HOUSEHOLD	YOUR INDIVIDUAL TOTAL (LBS. OF CO ₂)

PART II – WHAT CAN YOU DO?

DATA – WHAT CAN YOU DO?

Category	Actions You Can Take	Pounds of CO ₂ Saved Per Year
Waste Disposal		
Transportation		
Home Heating/Water Heating		
Electricity Use		

ANALYSIS – WHAT CAN YOU DO?

TOTAL SAVED (LBS OF CO ₂)	NUMBER OF PEOPLE IN HOUSEHOLD	YOUR INDIVIDUAL AMOUNT SAVED (LBS. OF CO ₂)

CONCLUSION QUESTIONS

1. How does your yearly household total compare to the total carbon dioxide emissions as recommended by the Kyoto Protocol?

2. What category produced the most CO₂ in your household? List ways you could reduce this total.

