STRATEGIC ENERGY INNOVATIONS

Grade: K-12

Version 1

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# School Transportation

## Assessment


**Evaluate the carbon emissions from daily transportation related to your school and identify strategies for more sustainable transportation methods**

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# Introduction

Transportation accounts for 28% of greenhouse gas emissions in the United States. These emissions come from our cars, trucks, busses, trains, and planes burning fossil fuels for energy. Over 90% of the fuel used for transportation is petroleum based[1]. To reduce the carbon emissions and improve local air quality at your school, begin by performing a School Transportation Assessment to make recommendations on how to reduce vehicle miles traveled (VMT) to and from school.

Performing an assessment helps us understand the current levels of transportation related emissions and sets a baseline from which we can judge our progress of reducing VMT. The following guide will help your school create an inventory of how students get to school, calculate school trip emissions, and perform a Car Tally.

[1] http://www.epa.gov/climatechange/ghgemissions/sources.html

## Lesson 1 Overview

**Estimated Time:**

1 hour

**Standards Covered:**

*NGSS:* 4-ESS3-1, 5-ESS3-1, MS-ESS3-5, MS-ESS3-3, HS-LS2-7, HS-ETS1-3

CCSS *Math:* 4.OA.1, 4.OA.2, 4.OA.3, 4.MD.2, 5.OA.1, 5.NBT.5, 6.RP.3, 7.RP.1, 7.RP.2, 7.RP.3, HS-N-Q-1,

CCSS *ELA*: Reading Standards K-5, Foundational Skills 3, 4; Writing Standards K-5, Production and Distribution of Writing 4; Writing Standards 6-12, Research to Build and Present Knowledge 7, Reading Standards 6-12, Integration of Knowledge and Ideas 7

**Objectives:** Students will be able to:

- Determine the amount of $CO_2$ emitted in their travel to school.
- Calculate emissions for various vehicles and occupancies.
- Understand how transportation contributes to climate change.

**Prep Time:**

30 minutes to review lesson

**Materials:**

- Handout 1.1 (one per student)

# Lesson 1: Calculating School Trip Emissions

Changing personal transportation choices is a critical step to protecting the climate. In this lesson, students will calculate the pounds of $CO_2$ released into the atmosphere from their commute to school. This exercise introduces students to the concept of passenger miles per gallon and underscores the important role that carpooling and public transportation plays in curbing air pollution and climate change.

## KEY WORDS

**Miles per gallon (MPG):** the number of miles a vehicle can travel on one gallon of fuel.

**Passenger miles per gallon:** the number of miles a single vehicle can travel on one gallon of fuel multiplied by the number of passengers

**Fuel-efficient vehicle:** vehicle that requires less fuel to travel compared to other vehicles.

## PREPARATION

Prior to this lesson, ask students to collect the following information on the vehicles in which they get to school: type of vehicle, miles per gallon, fuel type (diesel or gas), number of passengers including driver, and number of miles round-trip to school.

For Handout 1.1, students need to be comfortable with calculating multiplication and division math problems.

## SETTING THE STAGE

- Ask students:
    - To describe a time they rode the bus; ask them if the bus was full of people or mostly empty.
    - "Which uses more fuel, a bus or a car?" (A typical bus gets about 4 – 8 miles to the gallon, while most cars get over 20 miles to the gallon.)
    - "What form of travel do you think is more fuel-efficient, a full bus or car?" "Why?"
- Explain that the bus is more fuel-efficient because it uses less fuel to transport each person compared to many cars carrying only one person each.

## ACTIVITY 1: CALCULATE COMMUTE EMISSIONS

1. Explain to students that they will learn how to calculate the amount of fuel used on their daily trips to school and the quantity of $CO_2$ produced. Distribute a copy of Handout 1.1 to each student in the class.
2. Have students look at the chart titled "Average Miles per Gallon" on the handout. Ask students:
    - "Which type of vehicle gets the worst miles per gallon?" (The bus. Large trucks. Large SUVs.)
    - "Which type of vehicle gets the best miles per gallon?" (The hybrid car.)
    - "What are some things that determine how fuel-efficient a vehicle is?" (The size and type of motor help determine a vehicle's fuel efficiency. The weight of the car.)
3. Next, explain to students that **passenger miles-per-gallon** is a term to describe the number of miles that all passengers in a vehicle can travel on a gallon of fuel.
    - "What determines a vehicle's passenger miles per gallon?" (The number of passengers in that vehicle times the vehicle's miles per gallon.)
    - "How is a bus' miles per gallon figure different than the bus' passenger miles per gallon?" (The bus' will always get around 4 miles per gallon, but the bus' passenger miles per gallon will change depending on the number of riders.)
4. Have students complete Handout 1.1, providing assistance as necessary.

## ACTIVITY 2: PASSENGER MILES PER GALLON AND CLIMATE CHANGE

1. Once students have completed the handout, ask students:
    - "How do vehicles generate $CO_2$ and other forms of air pollution?" (A vehicle's engine combusts gasoline or diesel for power, and $CO_2$ is a byproduct of combustion.)
    - How does the fuel efficiency of a vehicle relate to the amount of $CO_2$ produced? (The more efficient the vehicle, the less $CO_2$ it will produce.)

- "How does increasing passenger miles per gallon decrease the amount of $CO_2$ generated per person?" (The more people riding in a vehicle, the fewer pounds of $CO_2$ will be generated per person in that vehicle.)

- "Why is riding the bus or carpooling better than driving in a car alone?" (Fewer pounds of $CO_2$ will be emitted per person in a bus or carpool than in driving alone in a car.)

2. Discuss student results and facts about vehicle emissions in the handout. Ask students to name ways they can reduce personal travel emissions, such as, walking, cycling, carpooling, or taking the bus.

## ASSESSMENT

Collect student papers to see if they were able to calculate the $CO_2$ emissions for various vehicles and occupancies. Look at question 10 to see if they understand the correlation between the mode of transportation and the amount of emissions produced.

## EXTENSIONS

1. **Handout Extension**: Calculate which vehicle gets the higher passenger miles per gallon – a minivan with six passengers or a hybrid car with two passengers? Students find the answer using the calculations in Handout 1.1.

2. **Travel Emissions Log:** Students keep a travel emissions log and track their emissions over a week or month. They are then asked to summarize their log and make suggestions about how they could improve their emissions.

3. **Sponsor Bicycle Workshops:** This project inspires students to increase their safe use of bicycles as an alternative to traveling by car. Local bicycle advocacy organizations offer free classes to your students on bike safety, bike maintenance and safe riding to and from schools. These organizations will lead short bike trips around the school, teach students about proper helmet use, proper signaling and the use of bike lanes. Coordinate with an organization to hold one or more bicycling workshops at your school (e.g., for after school or lunchtime programs, or as a special assembly).

4. **Community Tire Check / Inflation Days:** This project can inspire community members to pay closer attention to their tire pressure and maintenance as a way to save gas and reduce air pollution. Guide students in partnering with local filling stations to host tire check and inflation events. Set up a 'tire inflation station' at the school to check tires at the end of the school day. Work with students to develop and distribute a pamphlet about proper tire inflation and vehicle maintenance.
   Information on the benefits of proper tire inflation:
   http://www.carcare.org/Tires_Wheels/inflation.shtml

5. **Explore Food Miles in the Lunchroom:** Most food in the United States travels an average of 1,500 miles before it gets to the consumer's plate. This project inspires students to examine where their food comes from and the impacts that long distance transportation of food might have on the environment. Students can map where the ingredients of particular menu items typically come from (a hamburger equals bread from Kansas, tomato from Modesto, meat from Argentina, and cheese from Vermont). On the maps, indicate the distances from these locations to the school, estimate product weight and transportation (truck, rail, air, ship) and calculate total carbon costs for items. Recommend local food options and share results with students, administration, and families.
   Food miles resources: http://attra.ncat.org/farm_energy/food_miles.html

6. **Create a Local Bicycle / Walking Map:** This project can inspire more walking and biking by providing students with maps of routes for walking and biking to school. Invite a local biking or walking organization to the classroom to share information and lead school based local excursions. Work with the art teacher to make colorful and informative maps of different bicycle and walking routes. Coordinate an event to share the maps and encourage using them to travel to school.

7. **Create a Local Green Business Guide:** Work with students to collect information about local green products and businesses such as businesses that sell, manufacture, or encourage recycled carpets, EnergyStar® appliances, organic food, and green building materials and create a guide to share with school administrators, families, and the community.

# CALCULATING SCHOOL TRIP EMISSIONS

Name: _____ Date: _____

Students travel to school in many ways: some walk, some ride bikes, skateboards, or scooters; most ride in a car or take the bus. This lesson will assist you in developing a way to find out how many pounds of carbon dioxide ($CO_2$) you create by traveling to school each day. Remember that $CO_2$ is one of the main greenhouse gases contributing to climate change.

**Average Miles per Gallon Chart**

| | |
|---|---|
| Walk, Bike, Skate, Scoot | Food is your fuel, just keep eating! |
| Hybrid car | 48 miles per gallon |
| Small compact car | 30 miles per gallon |
| 2-seater sports car | 25 miles per gallon |
| Station wagon | 25 miles per gallon |
| Small pick-up | 22 miles per gallon |
| Minivan | 23 miles per gallon |
| Small SUV | 23 miles per gallon |
| Large pick-up | 16 miles per gallon |
| Large SUV | 15 miles per gallon |
| Motorcycle | 50 miles per gallon |
| Bus | 5 miles per gallon |

*If your parents know the exact city mileage of your vehicle, you can enter that as A for question #2.

1. What kind of vehicle do you usually take to get to school in the morning?

2. Now look at the chart above to find out how many miles the vehicle can go from burning up one gallon of fuel. What is the mileage of your vehicle?

A = _____ mpg

3. How many people usually ride in the vehicle?

B = _____ people

4. Multiply A times B. This is your Passenger Miles per Gallon.

C = _____ passengers mpg

5. Choose one of the next two choices. If you drive in a vehicle that uses gasoline, it creates 19.4 pounds of $CO_2$ gas for each gallon of fuel used. If you travel in a bus or diesel vehicle, it uses diesel fuel and creates 22.5 pounds of $CO_2$ gas for every gallon burned. Which is it for you? Write that below.

D = _____ lbs of $CO_2$

6. Now we will calculate the $CO_2$ produced per mile by the vehicle you take to school. Take amount D and divide by amount A.

Calculate D ÷ A E = _____ lbs

7. To determine the pounds of $CO_2$ per Passenger Mile for your vehicle, take amount E and divide by amount B.

Calculate E ÷ B F= _____ lbs

8. Determine the exact number of miles from your house to school (visit google maps or mapquest online).

G = _____ miles

9. Multiply the distance traveled (G) by 2 (for a round trip) multiplied by the Pounds of $CO_2$ per Passenger Mile (F) to know exactly how many pounds of $CO_2$ gas is created to commute to and from school each day.

Calculate G x 2 x F Pounds of $CO_2$ Gas = _____ lbs

10. What is the best way to reduce emissions from your commute and reduce your impact on the climate?