



Driving Reasons

Students calculate a car's fuel efficiency and analyze how to reduce fuel and environmental costs when driving.

Grade Level: (5–8) 9–12

Subject Areas: Driver Education, English Language Arts, Family and Consumer Science, Mathematics, Science, Technology Education

Setting: Classroom

Time:

Preparation Time: One-half hour

Activity Time: Two 50-minute class periods

Vocabulary: Efficiency, Miles per gallon (mpg)

Major Concept Areas:

- Consumption of energy resources
- Quality of the environment
- Management of energy resource use

Getting Ready: Find out or have students report current gasoline prices. Students will have to complete surveys in this activity at home.

Objectives

Students will be able to

- describe the fuel efficiency of an automobile;
- identify practices and habits to improve a car's energy efficiency; and
- relate fuel efficiency to environmental protection.

Rationale

Monetary and environmental costs are important things to consider as a car owner, driver, or passenger. An energy efficient car can help save money and reduce some of the ways cars damage the environment.

Materials

- Copies of the following pages:
 - *Calculating Miles per Gallon*
 - *Survey of Vehicle Maintenance*
 - *Action Ideas: Transportation Energy Efficiency Measures* (optional)
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Background

Many people's daily routines involve travel. We commute to school and work. We go to a store or a shopping mall to buy things. We run errands to the dry cleaner, and post office. We travel to restaurants, movie theaters, scout meetings, and sporting events. We visit friends and relatives.

Although the number of destinations we travel to may seem too numerous to keep track of, we can easily describe the types of transportation we use. The first that comes to mind is the automobile. Overall, automobiles and other private motor vehicles (minivans, SUVs, campers, motorcycles, and pickup trucks) are the dominant means by which we travel from one place to another. According to the Wisconsin Department of Transportation, "virtually all short-range rural trips, more than 90 percent of urban trips, and about 90 percent of all long-range trips are made in private motor vehicles." In addition, the number of miles driven each year per automobile in Wisconsin has increased from 9,770 miles (15,758 km) in 1980 to 13,100 miles (21,129 km) in 1995—a 34 percent increase. For some of us, automobiles are the only means of getting to our daily destinations. According to the 2012

Wisconsin Energy Statistics, transportation accounts for 26.7% of the total energy use in the state. End-use consumption for transportation increased by 1.8%, agriculture also saw an increase. All other sectors (residential, commercial, and industrial) saw a decrease.

Despite their dominance, automobiles are only one form of transportation that we use. Buses take us to school, to work, and between cities and towns within Wisconsin. Bicycling and walking are popular ways to commute within cities and towns. Airplanes carry us to business meetings and vacation destinations beyond our state's borders. Boats, bicycles, snowmobiles, and off-road motor vehicles are frequently used for recreational travel.

Transportation is a major energy user in Wisconsin, comprising 26 percent of total energy use in the state. Energy use by transportation has grown by 19 percent from 1980 to 1995. Nearly all the energy used for transportation comes from one energy resource—petroleum—which is used to make gasoline, diesel fuel, and jet fuel. Although alternative energy resources for transportation exist, their use is limited by current technical, economic, and institutional factors. Becoming aware of how energy is used by transportation, especially automobiles, is therefore an important first step toward learning how to use this energy efficiently.

Another consideration when driving cars is environmental costs. Every gallon of gasoline that is burned emits about 20 pounds of carbon dioxide into the atmosphere. Automobiles are the primary source of greenhouse gases, such as carbon dioxide, that could result in global climate change (for more information about greenhouse gases and global warming see the activity “Viewpoints”). Car emissions produce sulfur dioxide and nitrogen oxides that cause acid rain. Car exhaust helps create the smog and contributes to the ozone alerts that often plague much of southeastern Wisconsin. Traffic creates sound pollution that affects human and environmental health. There are many environmental costs associated with oil production used to produce gasoline (such as drilling impacts, oil spills, waste disposal). In addition to how car production and use affect the environment, building the roads we use to drive cars destroys habitat and adds pollutants to the air, land, and water.

There are many ways car production and use can be managed to save money and to be less damaging toward the environment. One of the first steps is to make sure a car uses fuel efficiently (see also Action Ideas: “Energy

Efficiency Measures” in the Energy Sparks Section). Energy-efficient cars save money and reduce air pollution. The less gasoline that is used means less money spent at the gas pump. Likewise, the less gasoline that is burned means less that has to be produced and less carbon dioxide that gets released into the atmosphere. Over the years, many car companies have worked to make their automobiles more fuel efficient.

Individuals can support the efforts of manufacturers and their representatives to build cars that have less impact on the environment. We can also be responsible to make sure the car we own runs efficiently. The fuel efficiency of motor vehicles used by family members can be checked directly by calculating the number of miles per gallon (mpg) the vehicle gets between trips to the service station. The mpg figure indicates how many miles the vehicle can travel on one gallon of gasoline. The higher the mpg figure, the more efficiently the vehicle uses energy.

Government regulations dictate the kind and quantity of emissions that are allowable. The most fuel-efficient automobiles currently on the market achieve overall mileages of over 39 miles per gallon on the highway, where fuel efficiency is the greatest. On the other hand, certain sport utility vehicles, sports cars, and large luxury cars may achieve overall mileages of less than 13 mpg. Overall, fuel efficiency ratings for automobiles in Wisconsin have increased substantially—from 15.2 mpg in 1980 to 21.6 mpg in 1994. However, fuel efficiencies have leveled off in recent years due to the increased popularity of pickup trucks, sport utility vehicles, and larger automobiles, which have lower fuel efficiencies.

Although the type of vehicle we drive is the main factor determining its fuel efficiency, other factors can cause efficiency to vary. City driving in stop-and-go traffic results in lower fuel efficiency than highway driving. Driving habits and how well the vehicle is maintained can also cause noticeable variations in fuel efficiencies. Inflating the tires to the proper pressure, tuning up the engine, aligning the wheels, and changing the oil and oil filter are maintenance measures that can contribute to increased vehicle efficiency.

In addition to checking fuel efficiency and properly maintaining their motor vehicles, individuals have other ways to help their cars be less damaging to the environment and to save money as well. Thoughtful planning when running errands can cut down on the fuel

we use. For example, making a list before shopping can prevent subsequent trips to the store to pick up forgotten items. Avoid wasted trips by making phone calls prior to leaving the home to make sure your destination is open and has the item you're seeking. Citizen groups can work with city planners to make sure new roads do not harm sensitive ecosystems. We should also become aware of how we travel on a day-to-day basis, and explore using alternative means of transportation to meet our travel needs. Walking, bicycling, carpooling, riding a school bus, and using public transit are alternatives that not only get us to our destinations, but can save us money, reduce traffic congestion, decrease air emissions, and improve energy efficiency as well.

Procedure

Orientation

Take a quick survey of how students arrived to school (how many walked, drove, were driven, took the bus, etc.). Have students compare the types and amount of fuel used by each mode of travel. Focus on the number of automobiles driven to school. Ask students if they are familiar with the term fuel efficient and if they know what it means. Do they think they drive or ride in fuel-efficient cars? Discuss ways students think they can learn if they drive an energy-efficient car. Note their answers.

Steps

1. Provide students with copies of *Calculating Miles per Gallon* and discuss the steps students should follow to figure out how many miles their or their family's car gets to the gallon. Also hand out copies of the *Survey of Vehicle Maintenance*. Instruct students to take

the activity sheet home and fill in the information and complete the calculations. Encourage them to have an adult family member assist them.

2. Have the class report their findings in a data table such as the one below. NOTE: You may want to collect and enter the data yourself to protect student privacy. Discuss similarities and differences. What other information do students think they would need in order to analyze variations?
3. Have students figure out how much gasoline they'll use in a year. They can base this calculation on how many miles they'll commute to school (and work) over a year's time (total the mileage per day and multiply it by the number of days they drive a year), or they can use an estimate of 13,000 miles per year (an average mileage for annual travel). Instruct them to divide the total (commuting mileage or 13,000 miles) by their car's fuel efficiency to determine the amount of gasoline used.
4. Tell students to calculate how much they'll spend on gasoline by multiplying the gallons of gasoline they'll use in a year by the average cost of gasoline. What do students think about this cost? If gasoline was \$.50 more expensive, how much would they spend?
5. Discuss other costs besides money that result from driving their cars. Inform students that for every gallon of gasoline they drive, their car produces nearly 20 pounds of carbon dioxide. Have them calculate how many pounds of carbon dioxide they'll produce in a year. What do they think about this amount?

Data Table for Class's Fuel Efficiency

Year	Make and Model	Miles per Gallon

Closure

Ask students to reconsider how they travel to school and around town. What suggestions do they have for reducing the amount of energy used (like walking, carpooling, using public transportation)?

Encourage students to explore ways they can improve their car's fuel efficiency (see also **Action Ideas: Transportation Energy Efficiency Measures**). Refer to the **Survey of Vehicle Maintenance**. Ask students to think how this information can help a car use less gasoline. Students may be interested in setting up a quick experiment to compare how far an inflated ball rolls compared to one that has lower air pressure. Make sure students use a consistent test to compare the balls. For example, they may want set up a ramp and release the balls at the same point and measure how far they roll. Encourage students to talk to a car mechanic about the importance of car maintenance.

Assessment

Formative

- How accurately did students complete the **Calculating Miles per Gallon** activity sheet and the **Survey of Vehicle Maintenance**?
- Did students correctly use their calculated fuel efficiency to determine their fuel costs?
- How extensively did students consider ways to increase their car's energy efficiency?

Summative

Have students look through a Consumer Reports Buying Guide or similar source and identify a car they would consider purchasing. Ask them to write an essay explaining to what extent fuel efficiency influenced their decision and why.

Have the class plan an imaginary (or real) field trip to an educational or historical site in Wisconsin. They should consider the amount of gasoline and cost per person

to get there using different modes of travel (like single passenger cars, car pooling, bus, plane).

Extensions

Have students plot road construction taking place in the community. Encourage them to find out the reasons and plans for the construction. If there are any projected construction sites, have students investigate the plans and attend city council meetings to learn about any issues involved. Invite a city planner to speak to students about considerations in road design.

Have students interview older citizens about how the streets looked in the past and design a map for what they think future roads will look like.

Challenge students to compare the energy usage and environmental impacts of various forms of transportation, including specific automobiles such as sport utility vehicles, bicycles, trains, buses, walking, and airplanes. Ask them to speculate about which forms of transportation are the most energy efficient (that is, use the least energy per person per mile traveled).

Students may have seen or heard of hybrid cars and electric vehicles. Contact the Midwest Renewable Energy Association to find out more about solar and electric vehicles (the-mrea.org).

Invite students to design a car of the future. They should consider the automobile's aerodynamics, safety, and fuel source.

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Calculating Miles per Gallon

Calculate the fuel efficiency in miles per gallon (mpg) of the motor vehicle you or your family uses. If you own or regularly use a vehicle, calculate the mpg for that vehicle. Otherwise, calculate the mpg for the vehicle that your family uses the most. NOTE: The terms motor vehicle and vehicle refer to cars, station wagons, minivans, campers, motorcycles, pickup trucks, and other motorized vehicles.

1. Write down the year, make, and model of your vehicle. _____
2. The next time you or someone in your family buys fuel for the vehicle, fill the fuel tank completely. If you have a trip odometer, set it to zero. Otherwise, record the beginning odometer reading in Box B below.

Ending odometer reading	A.
Beginning odometer reading	B.
Number of miles driven (Difference in odometer readings)	C.
Number of gallons of fuel	D.

3. When you or someone in your family again buys fuel, fill the fuel tank completely. Record the number of gallons of fuel bought in Box D. If you have a trip odometer, record the number of miles it shows in Box C. Otherwise, record the ending odometer reading in Box A.
4. If you have a trip odometer, go to Step 5. Otherwise calculate the number of miles driven by subtracting the beginning odometer reading from the ending odometer reading.
5. Calculate the fuel efficiency of the vehicle in miles per gallon (mpg) by dividing the number of miles driven by the number of gallons of fuel bought. Record your answer in the box below. NOTE: To get a more accurate fuel efficiency figure, repeat these calculations several times and find the average mpg (add the sum of all the calculations together and divide the total by the number of times you figured your car's mpg).

Miles per Gallon		City Driving	Highway Driving
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6. Circle whether the vehicle you calculated fuel efficiency for was used for city driving or highway driving. City driving represents stop-and-go driving at an average speed of 20 miles per hour, with the vehicle spending approximately 18 percent of its time idling (not moving while the engine is running) at stoplights and stop signs. The vehicle does not actually have to be driven in a city to meet these conditions. Highway driving represents driving on a mix of rural and interstate highways at an average speed of 48 miles per hour with very few stops.
7. If the vehicle was used for both city and highway driving, estimate the percentage of each.
 City _____% Highway _____%

Survey of Vehicle Maintenance

Check to see if the tires of the vehicle are properly inflated by measuring the pressure of each tire and comparing it to the manufacturer's recommended tire pressures. Measure tire pressure when the tires are cold. The tires are cold when the vehicle has been parked for some time or has only been driven at low speeds for a short distance.

Use a tire pressure gauge to measure tire pressure. See if someone in your family has a pressure gauge or borrow one from a service station. A pressure gauge is sometimes found on the handle of the air pump at a service station. Tire pressure is measured in pounds per square inch (psi). Most cars have tire pressure ranges from 28 to 32 psi, while the tire pressures for other vehicles will vary. Recommended tire pressures may be listed on the sides of the tires themselves or in the owner's manual for the vehicle.

The following procedures are recommended for improving fuel mileage and for properly maintaining the tires and engine. Record the month and year when this maintenance was last performed on the vehicle.

a) Today's date _____

b) Date of last wheel alignment _____

c) Date of last engine oil and oil filter change _____

d) Date of last engine tune-up _____

Action Ideas: Transportation Energy Efficiency Measures

Use Transportation Alternatives

- Walk or bike to destinations whenever possible.
- Start or join a carpool to commute to school or work.
- Use mass transit (buses, trains) for commuting purposes, when possible.

Maintain Vehicles for Greater Fuel Efficiency

- Keep the tires of your vehicle inflated to the manufacturer's recommended maximum pressure.
- Change engine oil and the oil filter according to the manufacturer's recommended schedule.
- Have your vehicle's engine tuned up regularly.
- Have the wheels of your vehicle aligned regularly.

Practice Driving Habits That Increase Fuel Efficiency

- Combine several errands into one trip.
- Reduce any unnecessary weight carried by the vehicle. Extra weight reduces fuel efficiency.
- If you stop for more than one minute, it is more efficient to turn off the engine than to let it idle.
- Avoid revving up the engine.
- Avoid rapid acceleration and braking. Drive smoothly and anticipate traffic stops.
- Obey speed limits. Most vehicles reach their optimum fuel efficiency at speeds between 40 and 55 miles per hour (mph) (64.4 and 88.5 km/hr). As speed increases over 55 mph (88.5 km/hr), fuel efficiency drops quickly. Speeds of 65 mph (104.6 km/hr) use from 10 to 15 percent more fuel than 55 mph (88.5 km/hr). Losses at 75 mph (120.7 km/hr) compared to 65 mph (104.6 km/hr) are even greater.
- Use cruise control when driving on level highway roads.

Consider Buying a More Fuel Efficient Vehicle

- If you or a member of your family plans to buy a new or used vehicle, consider choosing one with the highest possible fuel efficiency (miles per gallon, or mpg) rating. Small vehicles with four-cylinder engines and manual transmissions generally have the highest fuel efficiency ratings. However, fuel efficiency ratings also vary for different classes of vehicles (cars, minivans, station wagons, light trucks, etc.), so make sure to consider the most efficient vehicle within a certain class.

Trip Planning

- Design a travel brochure of Wisconsin that identifies energy-efficient ways of getting to various destinations and points of interest within the state.