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ABSTRACT

Designed to provide high school students with information concerning energy-efficient driving, this curriculum guide covers techniques of conserving energy, efficient use of motor vehicles, safe driving techniques, and development of energy-efficient driving habits. The guide consists of six lessons: (1) Fuel Conservation: Why It Is Essential; (2) Vehicle Selection; (3) Fuel Efficient Driving; (4) Planning Travel; (5) Proper Vehicle Maintenance; and (6) Practicing Fuel-Efficient Driving. Each lesson follows a typical format that includes the lesson goal, lesson overview, lesson topics, suggested learning activities, related materials, objectives, content, and audiovisual materials. Appended material includes summary of fuel economy savings, a gas mileage worksheet, thirty-three fuel-saving tips, a sample on-road situations evaluation, and a student test. (LRA)

DRIVER EDUCATION CURRICULUM GUIDE

Ohio Department of Education
Division of School Finance
Driver Education Section

FOREWORD

The energy crisis of late 1973 and early 1974 and the greater crisis of 1980 have signaled the end of an era for the United States, an era of unrestricted and ever increasing use of fossil fuel. Our country is facing and will continue to face a critical problem of fuel supply and demand in the years to come.

In this time of diminishing fuel supplies and increasing costs, it is critical that all Ohio citizens make more efficient use of our energy. Numerous solutions have been proposed and various measures have been instituted to deal with the energy problem. One of the most easily implemented and least restricted alternatives is energy conservation by drivers of motor vehicles.

High school driver education is the logical vehicle for teaching the concepts of safe, energy-efficient driving and energy conservation. Driver education offers new drivers an opportunity to learn fuel-efficient driving techniques before they might develop fuel-wasting driving habits. The purposes of this energy conservation curriculum guide are to assist students in developing safe driving habits and learning fuel-efficient driving techniques, to provide guidelines for energy-saving trip planning, and to provide guidance in the selection and maintenance of fuel-efficient vehicles for safe operation.

Franklin B. Walter

Franklin B. Walter
Superintendent of Public Instruction

PREFACE

The Ohio Traffic Safety Education Center (OTSEC), a project of the National Center for Research in Vocational Education (NCRVE) at The Ohio State University, is funded by the Ohio Department of Highway Safety, Governors Highway Safety Program, and monitored by the Ohio Department of Education, Division of School Finance, Driver Education Section. OTSEC was organized to provide assistance to the citizens and state departments of Ohio in five basic functional areas: research, development, services, education, and dissemination. These areas to a large extent parallel the functional areas of the National Center.

Within the five areas, driver and traffic safety education projects at OTSEC have been broad in scope. They have included such activities as developing driver education curricula for use in public schools, publishing a traffic safety newsletter for distribution throughout the state, developing a driver education information package for local school boards, developing research reports, conducting workshops, and many others.

The outcome of OTSEC's research, development, and education programs has been heightened awareness of driver education and traffic safety practices on the part of Ohio's citizens. By furthering this awareness, OTSEC has made and will continue to make a positive impact on traffic safety in Ohio.

Robert E. Taylor
Executive Director
The National Center for
Research in Vocational
Education

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CONTENTS

INTRODUCTION

Goals of the Guide

The purpose of the Energy Conservation Curriculum Guide is to provide information about driving in a safe and energy-efficient way. Experts agree that wise driving techniques and habits greatly affect the fuel economy of any automobile. They estimate that a fuel conscious driver should be able to get at least 30 percent better mileage than an "average" driver, and at least 50 percent better mileage than a poor driver. Since young, new drivers are in an impressionable period in the development of personal habits and attitudes, driver education is a timely vehicle for providing constructive instruction on energy-saving driving techniques, facts about inefficient energy usage, and general background information regarding automotive fuel consumption. This knowledge will help to equip young drivers with the information they need in order to become safe, energy-efficient drivers. Consequently, the following general goals are suggested as desirable outcomes of this unit. Students will:

1. cite evidence that voluntary fuel conservation by private citizens is the most immediate method of limiting dependence on imported oil;
2. demonstrate knowledge of the magnitude of energy-cost-comfort tradeoffs involved in vehicle selection;
3. demonstrate how to save fuel by minimizing or avoiding driving situations and maneuvers that waste fuel;
4. be able to minimize and optimize vehicle trips; and
5. demonstrate knowledge of the relationship between fuel economy and such aspects of vehicle maintenance as diagnosis, adjustments, and no-cost or low-cost routine repairs.

Guide Description

The Energy Conservation Guide consists of six lessons:

1. Fuel Conservation—Why It Is Essential
2. Vehicle Selection
3. Fuel-Efficient Driving
4. Planning Travel
5. Proper Vehicle Maintenance
6. Practicing Fuel-Efficient Driving

The same format is used in each lesson. The components of that format are explained below.

Lesson Goal

A lesson goal states, in broad terms, what students should accomplish as an outcome of the lesson. The goal provides a framework for identifying specific behavioral outcomes expected of the students.

Lesson Overview

A brief statement is provided regarding the background and rationale for the lesson.

Lesson Topics

Titles of the topics covered in each lesson are listed. They indicate the specific content areas contained within the lesson.

Suggested Learning Activities

Suggested learning activities, which correspond to the content, provide suggestions for developing the content in ways that are relevant to the students. Depending on the availability of instructional time, materials, or other factors, the teacher should select those activities that fit individual course goals and add to or modify the activities to suit local situations and needs.

Related Materials

Resources have been selected that are relevant to each lesson and that can be obtained free upon request. This list of related resources is included as Appendix A. Each related resource is numbered. These resources are referenced at the beginning of each lesson, under Related Materials. To find a specific resource, check Appendix A and find the number referenced.

Objectives

Objectives are desired instructional outcomes that give precise direction to the program of instruction and clearly establish the standards to be used in evaluating student achievement.

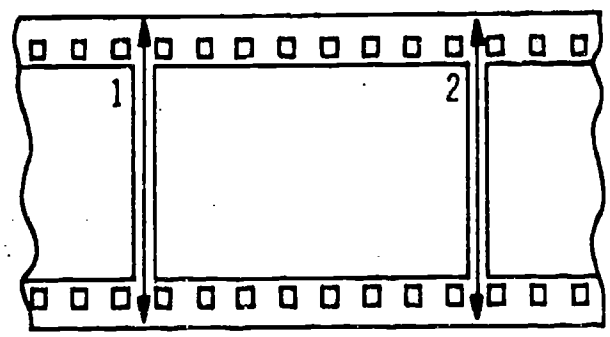
Content

Each lesson includes both basic and supplementary content. The basic content is considered essential background knowledge for the lesson. The supplementary content is designed to amplify or support the basic content and may be used at the discretion of the teacher depending on the constraints of time and the unique characteristics of each class.

Audiovisual Materials

Supplied with the guide is a roll of 35 mm slide transparencies. Each slide transparency is to be cut out (Fig. 1), inserted in a 35 mm slide mount (Fig. 2), and ironed in place. (Slide mounts can be purchased at any camera shop.) Once the slide transparencies are mounted, they should be numbered for easy identification to correspond to the number printed in the upper right-hand corner of the film frame.

FIG. 1

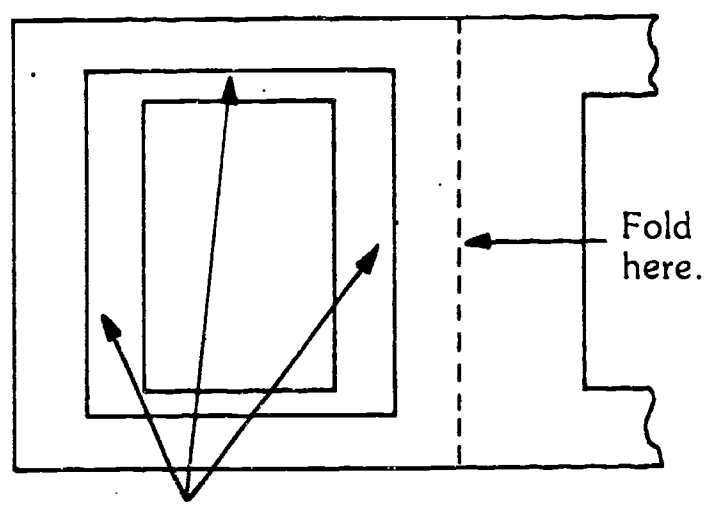


Cut outside edge of picture from top to bottom.

Each slide transparency is keyed to specific basic or supplementary content in the first five lessons and should be used to provide visual reinforcement for that content.

Slides 10, 22, 29, and 35 may be used in several ways. Although intended to be used as concluding slides for lessons two through five, they may also be used as introductory slides for those lessons or as a summary of the unit.

FIG. 2



Mount cut-out slide in this area.

Evaluation

The knowledge test included as Appendix G may be used to assess the extent to which the students understand the materials that have been discussed. Correct answers should be discussed after completion of the test.

How Good Is Your Energy Quotient (EQ)?

The following questionnaire may be used as an inventory to determine student awareness of various issues and as a challenge to provoke their curiosity prior to introducing the lessons on energy conservation. Also, it may be used as an introduction to Lesson 3, as a review quiz for Lesson 3, as part of the knowledge test, or as a pre and post test instrument.

How Good Is Your Energy Quotient (EQ)?

Decide whether each of these actions conserves or wastes gasoline. Circle C if you think the action conserves gasoline and W if you think it wastes gasoline.

C W 1. Pump the accelerator before starting the engine.

C W 2. Rev the engine to hasten warm-up.

C W 3. Use gasoline of the highest octane rating available.

C W 4. Maintain tires at the highest recommended pressure.

C W 5. Accelerate slowly when moving from a stop.

C W 6. Keep speed as steady as possible.

C W 7. Keep front wheels aligned.

C W 8. Observe the 55 mph speed limit on freeways.

C W 9. Carry extra weight in the trunk to improve traction.

C W 10. Equip the car with radial tires.

C W 11. Race the engine just before shutting off the ignition.

C W 12. Slow down gradually when nearing stop signs.

C W 13. Pass and merge rapidly with other traffic.

C W 14. Keep windows open for cooling at highway speeds.

C W 15. Reduce speed when driving into the wind.

C W 16. Reduce tire pressure before long trips.

C W 17. Combine short, single-purpose trips into one trip.

C W 18. Shift into high gear as soon as possible.

C W 19. Change lanes frequently when driving in congested traffic.

C W 20. Build up speed early when approaching a hill.

ANSWERS: (1) W (2) W (3) W (4) C (5) W (6) C (7) C (8) C (9) W (10) C (11) W (12) C (13) W (14) W (15) C (16) W (17) C (18) C (19) W (20) C

LESSON 1: Fuel Conservation—Why It Is Essential

Lesson Goal: Students will understand the seriousness of the energy shortage and will become aware of steps that can be taken to conserve fuel voluntarily.

Lesson Overview: This lesson introduces the energy shortage. It briefly discusses causes of the energy shortage and problems that have resulted from dependence on foreign supplies of oil. Four methods of individual fuel conservation are presented for further development in subsequent lessons. The primary instructional approaches are teacher-directed discussions and media presentations.

Lesson Topics:

Suggested Learning Activities:

1. As an introduction to the presentation of lesson content, ask students such questions as the following:
   a. What do you think about the current energy crisis and its future impact?
   b. What factors have led to the energy crisis?
   c. How can individual citizens and the country as a whole deal with this crisis?
2. Ask each student to identify how many family trips were made during the previous week with only the driver in the car. Compile the results and determine the class average.
3. Ask each student to observe traffic at a busy intersection and tally the number of persons in each of the first 100 cars or small trucks moving in one direction. Compile the results for the entire class. Determine the average number of occupants per vehicle.
4. Ask each student to conduct a simple survey, asking five neighbors the following questions: (1) How many different trips did you drive today? (2) How many miles did you drive today? (Estimate the total.) Compile the results from all students and divide the total miles by the total number of trips to find the average trip length.

Related Materials: 6, 11, 13, 18, 27, 32 (See Appendix A)

1.1 The Energy Shortage: Its Causes and Resulting Problems

Objective: Identify the two major factors that have led to the serious energy crisis of the mid and later 1970's and a major problem that has resulted from it.

1.1.1 Discuss the two major factors that have resulted in the serious energy shortage facing the United States. Use slide transparencies 1-3 to assist in the discussion.

BASIC CONTENT:

SLIDE 1 The energy shortage that now faces the United States is the result of two basic problems: increasing petroleum consumption and declining domestic crude oil production.

Increasing Consumption:

Although United States production increased by 300,000 barrels per day over the past four years, demand increased by two million barrels of oil per day over the same period of time. The United States uses one-third of all the oil used daily in the world.

SLIDE 2 The motorized transportation system, which is 96 percent oil-dependent, consumes 26 percent of the energy that is used in the United States. The private automobile consumes more than half of the transportation sector's energy; highway vehicles in total use 75 percent of transportation energy. This high rate of oil usage for transportation can be partially explained by two characteristics of American travel habits:

1. We habitually turn to the automobile for most trips without considering other means of travel. Almost 93 percent of our travel for outdoor recreation and 81 percent for visiting other people is done by automobiles and small trucks.

SLIDE 3 The most frequently made vehicle trip is only one mile. Trips of five miles or less make up 15 percent of the total miles driven every year. Yet these short trips account for 30 percent of all the gasoline used by private automobiles.

2. When we do drive, our automobile use is inefficient and vehicle capacity is wasted because we carry few or no passengers (the average occupancy is 1.3 persons both nationally and in Ohio). Over 70 percent of the American workers drive to work alone.

Declining Domestic Production:

Despite a surge in domestic oil drilling activity in recent years, the reserves/production ratio has continued to decrease. Since 1973 the new domestic petroleum reserves added each year have fallen far short of domestic production, although the price of newly found oil has been allowed to more than triple to encourage domestic production. In 1970, the United States was importing only 23 percent (3.4 million barrels) of the petroleum it needed. Currently we are importing nearly half our petroleum requirements (nine million barrels per day as of 1979).

Compounding the problem of domestic production is the fact that the United States has insufficient refining capacity to meet the rapidly increasing demand for gasoline, particularly for unleaded gasoline. Oil company efforts to build new refineries have been blocked for environmental reasons. In fact, only one major refinery has been built in the United States in recent years. This situation has intensified with the growing use of unleaded gasoline (almost 75 percent of all new cars and small trucks manufactured today require unleaded gasoline). Production of unleaded gasoline is more complicated and requires more crude oil per gallon than that of leaded gasoline.

1.1.2 Using slide transparency 4, discuss problems resulting from the energy shortage in the United States.

BASIC CONTENT:

SLIDE 4 High demand for oil and low domestic supply have resulted in this country's dependence on foreign sources of crude oil. In addition to political complications (such as American vulnerability to the whims and decisions of the oil-producing countries), this dependence has led to increasingly high fuel costs.

Reasons for rising gasoline prices (despite recent decreased consumption by American motorists) are complex, but a primary cause has been the escalation of foreign crude oil prices. The cost of Saudi Arabian light crude oil, for example, has risen from $1.26 per barrel in 1970 to more than $28.00 per barrel in May, 1980. Further price increases are seen as inevitable.

Other reasons for increased gasoline prices include the following:

1. Shipping and labor costs have increased substantially over the past five years.
2. Government price controls have been relaxed to help companies defray some of these rising costs.
3. Price regulations have changed to encourage investment in gasoline refinery hardware.

1.2 Voluntary Methods of Fuel Consumption

Objective: Identify four voluntary conservation methods that can be used by individual drivers to reduce fuel consumption without reducing transportation services.

1.2.1 Using slide transparency 5, discuss voluntary conservation methods that can be used by individual drivers to conserve gasoline. The Fuel Economy Savings handout in Appendix B may also be used to highlight this discussion.

BASIC CONTENT:

A number of ways to conserve fuel in the transportation sector have been suggested: use of synthetic fuels, reduction of motor vehicle weight, higher taxes on fuels, and development of motor vehicles that are less dependent on gasoline (such as the electric car). However, the most immediately effective method of reducing consumption is simply for motor vehicle drivers to conserve fuel. Conservation can be considered as a huge source of untapped energy. According to one source (Stobaugh and Yergin), conservation can be expected to yield an estimated savings of 40 percent of America's energy usage. Every American can help alleviate the energy supply problem by increasing the efficiency with which he or she drives.

Voluntary methods of fuel conservation can result in savings of gasoline and money without reducing transportation services. It is up to the individual driver and fleet operator to use more cost-efficient driving practices. Four methods of motor vehicle fuel conservation are listed below and will be discussed in greater detail in the lessons that follow.

SLIDE 5

1. The purchase decision. Choosing which vehicle to buy is the most important fuel economy decision that can be made. For example, a subcompact car that gets an average of 31 miles per gallon (mpg) can be driven 10,400 more miles on 800 gallons of gas (average annual use per car) than a mid-size car that gets 18 mpg average.
2. Driving techniques. Knowing how to drive for maximum fuel efficiency makes it possible for the average driver to reduce fuel use by as much as 20 percent.
3. Trip planning. Planning can help a driver both to minimize and to optimize vehicle trips. By deciding what errands are really necessary and planning them so as to consolidate vehicle use for several purposes, one can decrease cold starts and total miles driven.
4. Vehicle maintenance. Vehicle condition is an important factor in fuel consumption and overall cost of operation. Regular vehicle maintenance not only helps prevent breakdowns, but improves fuel economy and driver safety.

Using these cost-efficient driving practices can reduce gasoline consumption 20 to 30 percent. For an average family spending $800 a year on gasoline, this would mean a savings of $160 to $240 per year.

Voluntary conservation places the ultimate responsibility on those who are best able to judge their own needs and reduces the potential need for mandatory conservation measures.

LESSON 2: Vehicle Selection

Lesson Goal: Students will understand that selection of a vehicle for purchase should be based both on immediate transportation needs and on the estimated fuel-related costs of the vehicle.

Lesson Overview: This lesson discusses the importance of careful vehicle selection. It highlights the need for the driver to determine transportation needs and presents the factors to be considered in selecting a fuel-efficient vehicle. The primary instructional approaches are teacher-directed discussions and media presentations.

Lesson Topics:

Suggested Learning Activities:

1. Based on the discussion in section 2.1.1, ask the students to write down their families' immediate transportation needs and to rank those needs from most to least important. Then have each student investigate vehicle alternatives and select a new vehicle to meet the highest priority needs of the family.
2. Ask the students to develop a list of at least 15 items inside and outside a used vehicle to be checked before buying it. Compile the lists and distribute the results to all the students.
3. Have students interview new and used car dealers on the following topics and report their findings to the class.
   a. The effects of the energy shortage on car sales.
   b. Tips on buying a good used vehicle.
   c. Conservation-related features on new cars.
4. Ask the students to write a newspaper article on the effects of the energy shortage upon attitudes and actions of potential car buyers.
5. Divide the class into several small groups. Have each group discuss the advantages and disadvantages of using an older vehicle until it wears out. Have each group report their conclusions to the entire class.

Related Materials: 3, 9, 15, 17, 25, 26 (See Appendix A)

2.1 Determining Transportation Needs

Objective: Identify the five transportation needs that a driver should consider in selecting a new or used vehicle.

2.1.1 Ask the students how they would determine their transportation needs before selecting a new or used vehicle to buy. In the discussion that follows, identify the five factors described below. Slide transparency 6 may be used to accompany or summarize this discussion.

BASIC CONTENT:

Choosing a vehicle to buy is the most important fuel economy decision that a person can make. It is a decision that will affect the driver as long as he or she owns the vehicle.

A person who is buying a new or used vehicle should make a careful and realistic assessment of his or her vehicle needs in order to be able to select the most fuel-efficient vehicle that will satisfy those needs.

With fuel economy as a goal, the following factors should be considered in determining transportation needs:

SLIDE 6

1. Miles to be driven. Compute or estimate the total number of miles driven in the past year and adjust for significant changes that are anticipated. For example, adjust for changes in the places to which the vehicle is regularly driven (work, school, church, shopping, meetings, recreation, and so on).
2. Types of trips. Determine what kinds of trips make up the driving routine (for example, commuting, business travel, single or multiple errands, regularly scheduled activities, social events, and vacations). Consider whether mileage can be reduced significantly by combining trips, ridesharing, carpooling, or using public transportation.
3. Vehicle capacity. Determine how many people and how much cargo will normally be carried in the vehicle for the various types of trips. Keep in mind that the storage capacity of fuel-efficient subcompacts and compacts can be increased to that of larger vehicles with such options as:
   a. hatchback (the entire rear portion of the car can be used for cargo),
   b. station wagon design (wagons typically yield up to four times the luggage capacity of comparable sedan models),
   c. space-saver spare tires (these take up less room in the trunk, leaving more space for cargo), or
   d. small trucks (one-half and three-quarter ton), vans, and jeeps.
4. Driving environment. Consider the roadway characteristics, weather conditions, and traffic density in which the vehicle will normally be driven. Determine the vehicle characteristics needed to satisfy the physical requirements of the environment.

5. Cost of ownership and operation. The cost of vehicle ownership includes more than just the purchase price and the fuel. The real cost of owning and operating a vehicle also includes the following:

   a. finance charges (if necessary)

   b. sales tax

   c. license and registration fees

   d. insurance premiums (rates vary according to the price and class of the vehicle, who drives it, where it is driven, and other factors)

   e. maintenance and repair costs (rates vary per hour and the convenience of service varies)

   f. tires (replacement tires and snow tires)

   All of these costs will vary with each vehicle. The total cost of ownership and operation should be considered in vehicle selection.

2.2 The Importance of the *Gas Mileage Guide*

Objective: Explain the purpose of the *Gas Mileage Guide* and the value of using it in selecting the most fuel-efficient vehicle that meets personal transportation needs.

2.2.1 Using a copy of the *Gas Mileage Guide*, which may be obtained from local car dealers or resource 26, page 49, discuss the importance of the guide in vehicle selection.

BASIC CONTENT:

The *Gas Mileage Guide*, issued by the Environmental Protection Agency (EPA), gives information about the relative fuel economy performance of current vehicle models.

The "estimated miles per gallon" ratings are determined under simulated driving conditions. These tests do not represent actual road tests. Each vehicle is tested under precisely controlled conditions by professional drivers in a laboratory on a dynamometer. The dynamometer is a machine that permits exact simulation of the vehicle's operation under various driving conditions. Temperature is controlled in the laboratory in a range of 68 to 86 degrees F. in order to provide the same temperature conditions for all vehicles. Neither automobile manufacturers nor the EPA guarantees that individual drivers will get the same mileage under actual driving conditions. Estimates are provided to enable car and small truck buyers to compare the performance of one vehicle with that of another.

Under actual driving conditions, the following factors will cause deviations from the EPA results:

1. individual driving habits
2. vehicle performance capability
3. vehicle condition (especially important for used vehicles)
4. number and types of accessories
5. road, weather, and traffic conditions
6. average trip length and cargo

SUPPLEMENTARY CONTENT:

Once transportation needs have been outlined, the vehicle size (class) that meets those needs can be determined. The EPA has divided passenger cars into four groups—subcompact, compact, mid-size, and full-size—based on interior measurements (the combination of front seat, rear seat, and trunk space).

When you have an idea of the kind of vehicle that meets your needs, look up road test results that appear in automobile and consumer magazines. These magazines provide information on such factors as gas mileage, repair records, roominess, comfort, safety, and performance.

After making a tentative selection of make and model, be sure you know and like everything about the vehicle before buying it. Conduct a careful and complete inspection, including a thorough road test to determine handling and performance. Be sure to consider the safety features of the vehicle with driving habits, transportation needs, and family size in mind. If possible, have the entire family take part in the road test.

2.2.2 Discuss the important steps that a prospective buyer should use in selecting a good used vehicle.

BASIC CONTENT:

When shopping for a used vehicle, the same fuel-efficient characteristics, features, and options as for a new vehicle should be sought.

Another very important consideration is the mechanical condition of the vehicle. Whether the vehicle is bought from a dealer or from an individual, it should be thoroughly inspected by a reputable mechanic. Try to gather as much information about the vehicle as possible. Check the record of repairs and service. Talk to the previous owner. Check such sources as the *Kelly Blue Book*, which publishes current price ranges on all used vehicles, or publications of the Consumers Union, which publishes performance ratings and repair costs of various used models. Considerable money can be saved in repair costs and paying for substandard gas mileage by following these procedures.

2.3 Basic Vehicle Factors

Objective: Identify the vehicle characteristics and equipment that should be considered in selecting and equipping a vehicle to achieve good gasoline mileage.

2.3.1 S ne discussion by asking the students to name the most important vehicle factors to be considered when choosing and equipping a vehicle for the greatest possible fuel economy. As the discussion develops, include those listed below and use slide transparencies 7, 8, and 9 to assist in the discussion.

BASIC CONTENT:

SLIDE 7 The following five basic factors should be considered in comparing cars within a particular class for the greatest possible fuel economy. In addition, several supplementary factors, listed as item 6 below, may merit consideration.

SLIDE 8

1. Weight. Vehicle weight is the most significant variable affecting fuel consumption. The heavier the vehicle, the more energy it requires and the more fuel it consumes. Each additional 100 pounds of vehicle weight requires an extra 15 to 17 gallons of fuel per year.

2. Aerodynamic design. The smaller the frontal area of a vehicle (and therefore the lower the air resistance), the better the gas mileage that will be obtained. In steady, high-speed driving most of the engine power is used to overcome aerodynamic drag.

3. Engine size and type. The smallest engine available in the chosen vehicle model is the most economical choice. Four-cylinder or small six-cylinder engines are all that most cars and small trucks require for the average person's driving needs. Large engines in small cars and small engines overloaded with heavy power options are not wise choices because they use more fuel than necessary.

   The type of engine also influences the number of miles that can be driven on a gallon of fuel. Two good alternatives are:

   a. Diesel. According to the EPA, the diesel engine gets 40 to 70 percent better mileage than the gasoline engine. For cold start and cold running conditions and speeds under 30 mph, the diesel engine performs 100 percent better than the gasoline engine. In addition, diesel engines require less engine maintenance than standard gasoline engines.

   b. Turbo-charge. This type of engine produces more efficient performance under normal driving conditions because more air is pumped into the cylinders, allowing a leaner fuel mixture to be burned. This improves engine performance and reduces exhaust smoke, engine noise, and fuel consumption.

4. Type of transmission. With all other factors (weight, model, and engine size) being equal, manual transmission vehicles generally get substantially better gas mileage (usually between two and four miles per gallon better) than vehicles with automatic transmissions, especially at speeds below 35 mph. However, a manual transmission vehicle driven improperly can waste fuel if the operator revs the engine while shifting, stalls the engine, or runs the engine in the wrong gear.

SLIDE 9

5. Tires. Radial tires enable a vehicle to get three to ten percent more miles per gallon than do conventional belted-bias or bias tires. The advantages of radial tires over belted-bias tires, depending on the vehicle and the driving conditions, include the following:

   a. less rolling resistance

   b. longer-wearing tread

   c. better road-gripping traction, which improves steering and cornering responses

   d. less drag on the horsepower of the vehicle at highway speeds

   Radial tires should never be mixed with other kinds of tires (except radial snow tires), as serious problems in directional stability can result.

6. Other factors. The following characteristics and equipment options may also merit consideration in selecting a fuel-efficient vehicle.

   a. Overdrive. This feature provides an extra gear ratio to reduce the speed of the drive shaft to about 80 percent of the speed of the engine. With the overdrive in operation at cruising speeds, gas mileage can be increased by ten percent or more.

   b. Rear axle ratio. A low rear axle ratio is normally more efficient than a high ratio because the engine must power the drive shaft fewer times to turn the wheels once. This allows the engine to turn more slowly at a given speed, thereby reducing engine wear and saving fuel.

   c. Electronic fuel injection. This option saves fuel by more precisely matching the amount of fuel injected into the cylinders to the needs of the engine. Cold starting, idling, acceleration, and cruising are controlled electronically so that fuel is injected in the proper amounts to satisfy these different engine operating conditions.

   d. Electronic ignition. This option saves fuel by providing better combustion and less chance for spark plug fouling, which wastes fuel.

   e. Color. Light exterior and interior colors keep a vehicle cooler in warm weather by reducing heat build-up. In air-conditioned vehicles, this reduces the required output and operating time of the air conditioner.

SUPPLEMENTARY CONTENT:

Effects of vehicle and engine size on fuel economy:

The economy of driving small vehicles with small engines is revealed by the following costs per mile for 1980 models of the four vehicle size groups.

These "per mile" costs are based on 15,000 miles driven annually and include gas, oil, maintenance, and tires. Figure ranges represent low cost and high cost areas of the country.

Subcompact (4 cyl.)	5.30¢ - 7.00¢
Compact (6 cyl.)	6.50¢ - 8.30¢
Mid-Size (6 cyl.)	6.85¢ - 8.90¢
Full-Size (8 cyl.)	8.15¢ - 10.60¢

New designs in automatic transmissions:

Newer automatic transmissions are lighter than the older ones and improvements such as torque converters and lower gear ratios make them more fuel-efficient. Lock-up torque converter automatics can effect a two to six percent improvement in fuel economy over conventional automatics.

Power options:

Power options increase a vehicle's power requirements in two ways: (1) by using power and (2) by adding weight.

An air conditioner typically increases average fuel consumption by nine percent, or by as much as 20 percent in stop-and-go traffic. Other options, such as power seats and windows, add weight to the vehicle and require extra fuel both to carry and to operate them.

On subcompact or compact vehicles, power accessories decrease gas mileage even more than on larger vehicles because the added weight creates strain on the engine. Most power options are not needed on smaller vehicles.

SUMMARY: Lesson 2 may be summarized as follows using slide transparency 10:

SLIDE 10 — Less weight and size + Streamline design + Smaller economical engine + Fuel-efficient transmission + Radial tires + Fewer energy-consuming options = More Miles Per Gallon.

LESSON 3: Fuel-Efficient Driving

Lesson Goal: Students will realize that safe, fuel-efficient driving is determined in part by the driver's attitude, driving experience, and driving techniques.

Lesson Overview: This lesson explains safe driving techniques that can improve fuel economy and those that waste fuel. In Lesson 6 these techniques will be practiced in the car and students will be evaluated in terms of how well they use these techniques in actual driving situations.

Lesson Topics:

Suggested Learning Activities:

1. Ask students to identify the correct method of accelerating when (1) climbing a steep hill, (2) merging into high-speed traffic, (3) passing a large vehicle, (4) starting up on gravel, and (5) leaving a traffic signal when it is snowing.
2. Ask students to identify excuses for speeding, problems caused by excessive speed, and ways speeding can be reduced.
3. Ask students to write a short editorial for the school newspaper on the advantages of the 55 mph speed limit.
4. Ask students to name ways to avoid unnecessary braking when (1) approaching an intersection to make a right turn, (2) cresting a steep hill, (3) driving in congested city traffic with traffic signals, and (4) driving on a rural highway with many curves.
5. Ask students to maintain a log of the time spent with the engine idling in one week. At the end of the week, have them compute how much fuel was consumed while the engine was idling. Compute the amount of fuel wasted using the rule that two minutes idling equals one mile of driving.

Related Materials: 5, 9, 10, 12, 13, 20, 21, 25, 28, 29, 30, 31, 33 (See Appendix A)

3.1 Fuel-Efficient Driving Techniques

Objective: Describe three driving techniques drivers should use to reduce fuel consumption.

3.1.1 Discuss the important fuel-saving techniques described below, using slide transparencies 11 through 17 to assist in the discussion. Highlight the discussion by describing examples of situations in which the maneuvers can be implemented.

BASIC CONTENT:

SLIDE 11 The most important elements in achieving fuel economy are the driver's attitude, experience, and safe driving techniques. Fuel-efficient driving techniques, such as those described below. can enable the average driver to reduce fuel consumption by as much as 20 percent. (And there is a bonus—the economical way to drive is the safe way to drive.)

SLIDE 12 1. Accelerate smoothly. Moving from a complete stop requires up to three times as much fuel as driving at a cruising speed. The most fuel-efficient method is to accelerate quickly and smoothly, without "flooring it," to minimize the time spent accelerating to reach cruising speed.

When starting on sand, snow, ice, or other slippery surfaces, depress the gas pedal gently to avoid spinning the wheels and wasting fuel. When traction is established, accelerate as described above.

SLIDE 13 2. Drive at moderate, steady speeds. As speed is increased, so is the vehicle's wind resistance. This is the main reason that higher speeds produce lower gas mileage. All vehicles have a speed range in which they achieve their best fuel economy. Speeds of 30 to 45 mph are generally considered best for maximum economy.

On the freeway, where a higher speed must be maintained, drive between 50 and 55 mph. Department of Energy tests have shown that drivers can obtain from 15 to 18 percent better gas mileage at 55 mph than at 70 mph. Driving at 55 also saves lives.

Keeping a steady speed helps to maintain the vehicle's momentum and reduces fuel consumption. Repeatedly varying the speed between 50 and 60 mph can waste 1.0 to 1.5 miles per gallon. On long trips, cruise control is effective in maintaining a steady speed.

3. Anticipate conditions. Anticipating traffic situations and responding to them properly has the potential of saving more fuel than any other driving behavior. Each time the brakes are used to reduce speed, the energy that was used to achieve the higher speed is wasted. In order to maintain momentum and avoid slowdowns or sudden stops, the following techniques should be used.

SLIDE 14

a. Drive defensively. Constantly scan and evaluate traffic conditions. Awareness of conditions ahead enables the driver to control the vehicle's movement, speed, and position for more economical and safe driving.

b. Look well ahead. Extending the visual field 12 seconds down the road can help to reduce unnecessary braking, acceleration, and steering changes.

SLIDE 15

c. Maintain a space cushion. Leave a two-second following distance behind other vehicles and keep an eye on the traffic at least two vehicles ahead in stop-and-go traffic. These techniques make it possible to move into the lane that provides the smoothest movement through congested traffic.

d. Don't tailgate. Tailgating is unsafe; it destroys driving tempo and leads to jerky movements that waste momentum.

e. Look to the side and rear. Awareness of side and rear traffic enables the driver to change lanes more easily where there are slowdowns ahead. On roads with more than one lane moving in the same direction, the driver should choose the lane that allows for the smoothest movement and the least amount of potential conflict.

SLIDE 16

f. Read the signs and signals. Signs and signals tell the driver what is ahead. Driving efficiency can be increased by anticipating stop signs, traffic signals, exits, and other features, and adjusting speed and position accordingly.

On frequently traveled roads, learn to "read" the traffic light patterns. For example, if lights are synchronized to encourage a certain speed, try to maintain that speed. If you see that a light is going to turn red before it is reached, decelerate early. If the light turns green, some momentum will have been maintained and acceleration will be more economical.

SUPPLEMENTARY CONTENT:

Economical Use of the Transmission:

With a manual transmission, do not drive too long in the lower gears. For minimum fuel consumption, shift through the lower gears smoothly and quickly and build up speed gradually in high gear. Driving a vehicle in second gear uses about 45 percent more fuel than driving it in fourth (high) gear.

With an automatic transmission, depress the gas pedal enough to start the vehicle moving. At about 28 to 30 mph, let up slightly to ease the transmission into high gear as quickly as possible.

More About 55 mph:

SLIDE 17

One of the myths about the 55 mph speed limit is that driving 55 does not save gas and that one actually spends more money because it takes more time to reach the destination. This is untrue. Traveling at higher speeds usually causes a driver to have to adjust the speed frequently when slower traffic is encountered. A measurable loss in fuel economy occurs with excessive lane changing and speed variation.

Observing the 55 mph speed limit on the open highway will improve a driver's chances of avoiding an accident. The slower the speed, the less distance it will take to stop the vehicle safely. At 70 mph the chances of surviving an accident are only 50-50. At 55 mph the odds of survival are 31 to one in the driver's favor.

Accelerating on Hills:

Driving uphill uses more gas than driving on flat roads. When approaching a hill, accelerate just before beginning the climb. Using the car's momentum in this way uses less gas than accelerating against the resistance of the grade. Once over the crest, ease off the gas pedal and let gravity help. Less gas is needed on a downhill grade.

3.2 Gas-Wasting Driving Habits

Objective: Identify common gas-wasting driving habits and explain the better technique in each case.

3.2.1 Discuss the common gas-wasting habits described below, using slide transparencies 18 through 20 to assist in the discussion.

BASIC CONTENT:

The following driving habits are typical of many drivers. Some drivers believe some of these are fuel-efficient techniques when, in reality, they are all gas-wasting habits.

SLIDE 18

1. Pumping the accelerator. When starting a vehicle, the driver should depress the gas pedal once to set the choke. Pumping the accelerator when the motor won't start right away only wastes gas by pulling it through the engine and out the tail pipe.

2. Warming the engine. Although it is commonly accepted that it is harmful to move a vehicle before the engine is fully warmed, recent studies have shown that a vehicle can be safely operated after only a 30-second warm-up. After this brief period of idling, the vehicle should be driven at slow speeds for the first few blocks to complete the warm-up.

3. Racing the engine. When temporarily stopped at a traffic signal or stop sign, avoid racing the engine. This is purely wasteful. Also avoid racing the engine before shutting it off. This action dumps raw gasoline into the cylinders, washing away the protective oil film and thus increasing wear on the engine when it is restarted.

4. Using the accelerator as a brake When stopped on a hill, do not use the accelerator as a brake.

SLIDE 19

5. Excessive idling in traffic. Do not let the engine idle for more than 30 seconds in traffic. Two minutes of idling wastes enough fuel to drive a mile. It takes less gas, if the accelerator isn't used, to restart a warmed engine than to let it idle. Whenever possible, avoid rush hour traffic by selecting alternate routes or leaving earlier or later than the crowd.

6. Riding the brake Do not hold the left foot on the brake pedal while driving.

7. Unnecessary use of the heater Turn off the heater fan when traveling at speeds over 40 mph. At these speeds normal air resistance will force plenty of air through the intake of the heating ventilation system to warm the vehicle.

SLIDE 20

8. Driving with open windows When driving at 40 mph or more during warm weather, it usually takes more power to overcome the wind resistance caused by open windows than it does to run an air conditioner at low speed

3.3 Fuel Efficiency and Special Conditions

Objectives: Describe two reasons that it is difficult to maintain fuel-efficient speeds when driving at night or when the roads are wet or snow covered.

Identify five fuel-saving techniques for bad weather driving.

3.3.1 Discuss poor visibility and poor traction as two main impediments to achieving good gas mileage when driving at night or when roads are wet or snow covered. Outline the fuel-saving techniques for bad weather driving, emphasizing the importance of anticipating potential problems. Use slide transparency 21 to accompany this discussion.

BASIC CONTENT:

Maintaining a fuel-efficient speed when driving at night or on wet or snow-covered roads can be extremely difficult because these conditions often require slower than normal speeds. There are two main reasons for this.

1. Darkness reduces visible detail and conceals hazards, making it more difficult to judge the speed and position of other vehicles at night. Drivers must depend largely on their headlights for illumination, so they need to be more alert in order to drive safely and economically.
2. On wet or snow-covered road surfaces the engine uses more horsepower to overcome the poor traction. Fuel economy under these conditions can be reduced by as much as one mile per gallon.

Some fuel-saving techniques for bad weather driving are listed below. It should be noted that most of these techniques depend on planning and anticipation.

SLIDE 21

1. Leave early. Expect the trip to take twice as long as normal. Trying to make up time causes drivers to drive too fast for the conditions and to take risks. Hurrying may also make a driver neglect to use the fuel-efficient driving techniques he or she would use under normal conditions.
2. Plan the route carefully. Avoid steep grades and lightly traveled roads when possible.
3. Maintain steady speed. Although speeds will be lower in critical traction situations, maintain as much vehicle momentum as possible.
4. Anticipate. Constantly scan conditions ahead and slow down early. Slick pavements reduce traction and can cause the driver to lose control. Anticipating conditions well in advance can provide the time and distance needed to react safely.
5. Increase following distance. It takes three to ten times more distance to stop on slick pavement than on dry pavement. Increase following distance to at least four to six seconds.

SUPPLEMENTARY CONTENT:

Stay off roads when travelers' warnings are issued. If you are away from home and road conditions suddenly become dangerous, stay where you are. It is better to wait the storm out away from home than to get stuck somewhere without help.

If you do get stuck, don't panic. Unless there is a house or help in sight, stay with the vehicle. For warmth, run the engine for 15 minutes at a time. To conserve gas, wait at least 15 minutes before starting it up again. Clear snow away from the exhaust pipe to eliminate the possibility of a carbon monoxide build-up. Always plan ahead for serious trouble in winter by storing emergency equipment in the trunk.

3.4 Fuel Consumption Records

Objectives: Explain why it is good practice for a driver to keep accurate records of a vehicle's fuel consumption.

Compute miles per gallon and cost of gas per mile using sample problems.

3.4.1 Explain the importance of keeping accurate fuel consumption records, as discussed below.

Using the Gas Mileage Worksheet in Appendix C, show the students how to compute miles per gallon (mpg) and cost per mile (cpm) driven. Then have them complete the problems on the worksheet.

BASIC CONTENT:

It is good to establish a vehicle's overall fuel consumption (miles per gallon) in order to determine month-to-month fuel usage, to compare present mileage with the mileage achieved when the vehicle was new, and to help determine when a tune-up or minor adjustments are needed.

By comparing actual driving records, an increase or decrease in fuel consumption may be spotted. This can signal a need for repair or maintenance. It also tells when you are driving in a fuel-efficient manner.

As part of the mileage record, the driving conditions (city or highway driving, presence of cargo, road and weather conditions, temperature, and so on) should be recorded. Note that cold weather lowers gas mileage by requiring a longer time for the vehicle to warm up. Each 10 degrees F. drop in temperature lowers gas mileage by about two percent.

SUMMARY: Lesson 3 may be summarized as follows using slide transparency 22:

SLIDE 22 — Accelerate smoothly + Travel at steady speeds + Anticipate conditions ahead + Maintain your car's momentum + Be patient = More Miles Per Gallon.

LESSON 4: Planning Travel

Lesson Goal: Students will understand that planning for the most efficient travel pays off in savings of valuable fuel, time, and money.

Lesson Overview: The focus of this lesson is how to minimize the number of trips while optimizing their usefulness. Techniques discussed include planning short trips, choosing routes that use the least fuel, and using other fuel-efficient alternatives. The primary instructional approach is teacher-directed discussion. Slide transparencies are also used to assist in the discussions.

Lesson Topics:

Suggested Learning Activities:

1. Divide the class into several groups. Choose a destination familiar to all students and ask each group to plot the most fuel-efficient route (time, location, course, vehicle) from the school. Ask each group to explain its reasons for selecting the route. Repeat the activity using new destinations.
2. Using Ohio road maps, check students' knowledge of the meanings of markings and symbols on a map legend. Have students locate several towns and cities on the map. Identify several trips (from point A to destination B) and have the students select the best routes and compute the distances between points and the time needed to drive those distances.
3. Using Ohio road maps, have each student plan a route for a trip of at least 300 miles, all within Ohio, including at least one large city. Have them identify stopping points, the routes between points, the number of miles between points, and the total time of their trip.
4. Ask the students to maintain a family trip log for two weeks; include the following: (1) number of trips taken, (2) purposes, (3) distances, and (4) travel time. Have the students bring their logs to class. Discuss the following: (a) How many single-purpose trips were taken? (b) How many could have been combined? (c) How many were planned to save fuel? (d) How many were less than five miles? (e) For how many trips could an alternative mode of transportation have been used? (f) If more than one vehicle is owned, how many trips were planned using the vehicle that gets better mileage?

   Compile the results and present them to the class. Ask the students to identify trends that are typical of their class. Have them develop a list of recommendations to help their families improve their patterns of vehicle use and trip planning.

Related Materials: 5, 9, 10, 13, 22, 24, 25 (See Appendix A)

4.1 Short Trips Waste Fuel

Objective: Name four reasons that short trips waste fuel.

4.1.1 Discuss why cold-start, short trips impose a heavy fuel penalty on the traveler. Slide transparencies 23 and 24 may be used to assist in the discussion.

BASIC CONTENT:

SLIDE 23 Short, single-purpose trips waste fuel because the parts of the vehicle never fully warm up. Tests have shown that a car that gets 13½ miles per gallon (mpg) when fully warmed up in 70-degree weather will start a trip getting only three mpg and at the end of three miles will have reached nine mpg. In 10-degree weather, the fuel penalty is even worse. Fully warmed up, the same car would get 12¾ mpg, but on cold start would begin with less than two mpg, working up to nine mpg at the end of five miles.

Driving a vehicle on short trips affects gas mileage because of the following factors:

1. Tire resistance. Tires resist motion until they are warmed and the air pressure has increased.
2. Engine resistance. Lubricants within the engine flow better and therefore perform better after they have warmed up. A richer fuel mixture is also required in a cold engine to overcome the poor air-fuel mixing.
3. Vehicle resistance. All the parts of the vehicle resist motion at first. Proper lubrication occurs only after resistance is lowered, and resistance is lowered only after the vehicle has been driven about 15 minutes.

SLIDE 24 4. Stop-and-go driving. Short trips are also wasteful because they tend to consist primarily of low-speed, stop-and-go (cyclic) driving. Low speeds and excessive stopping and starting are less fuel-efficient than steady, moderate speeds.

SUPPLEMENTARY CONTENT:

McDonald Douglas conducted a test on the effects of cold starts and short trips on fuel consumption. A V-8 equipped sedan at an ambient temperature of 30 degrees was started, idled for 30 seconds, and driven. The test was conducted in city driving conditions with 12 stops for traffic lights, stop signs, and other urban traffic problems, and at relatively slow speeds. The vehicle used fuel at the rate of one mile per gallon. This same vehicle, warmed up and driven for 20 miles, averaged 17 miles per gallon.

4.2 Planning Short Trips

Objective: Identify at least four factors to consider in planning short trips and five factors to consider in planning long trips.

4.2.1 Discuss the advantages of trip planning, using slide transparency 25 to assist in the discussion.

BASIC CONTENT:

A driver who plans trips spends less time behind the wheel, eliminates unnecessary trips, drives fewer miles, and reduces fuel costs. Trip planning begins with taking a serious look at present travel habits and recording the number of trips taken in a given time period, the purposes of those trips, and the average miles traveled per trip. These observations should be made with a view toward combining trips because the more that trips are consolidated, the more fuel can be saved.

SLIDE 25 For example, one or two consolidated trips are more fuel efficient than five or six shorter trips in which the driver goes back and forth from home several times. This is because the vehicle parts

1. have time to warm up,
2. stay well lubricated for 15 to 20 minutes after individual stops, and
3. stay warmed up for three to four hours after stopping.

4.2.2 Discuss the following four main factors to consider when planning short trips. Use slide transparency 26 to highlight or summarize the discussion.

BASIC CONTENT:

The following factors should be considered when planning short trips.

1. Time. Trips that need to be made in the same time period (for example, in the morning) should be examined to see if they can be combined into a single trip.
2. Location. Trips to places in the same general area or direction often can be combined into a single trip.

SLIDE 26

3. Course. Plan the course of travel efficiently by:
   a. selecting routes that require the least fuel consumption (for example, freeway driving is nearly twice as economical as driving in heavy city traffic) and
   b. deciding on the best order in which to make stops.
4. Vehicle. If more than one vehicle is available, conserve fuel by making the greatest use of the vehicle that consumes the least amount of gasoline or the vehicle whose engine is still warm. In selecting the best vehicle to use, consideration may also need to be given to trip length, cargo and passenger requirements, and road and traffic conditions

4.2.3 Discuss the following factors to consider when planning longer trips, such as vacations.

BASIC CONTENT:

The following factors should be considered when planning long trips.

1. Destination and route. Know where you are going and plan the route in advance. Select familiar roads to help save fuel and time. Ask for directions before you leave if you have any doubt. Automobile clubs are ready to help in planning and preparing for a fuel-saving vacation by suggesting shorter routes and tie-in transportation arrangements.
2. Planning records. Make careful notes about your trip plans, including:
   a. approximate mileage to destinations,
   b. specific routes,
   c. important decision points, such as turns or exits, and
   d. planned stops (for rest, meals, sightseeing, and so on).
3. Availability of fuel. Check on the availability of gasoline along the planned route.

   Drivers in each of the contiguous states can get information on gasoline availability through the Discover America Travel Organization, which is the national association of the United States travel industry. The national toll-free telephone number is (800) 238-8000.
4. Weather and road conditions. Check these conditions along your route as part of pretrip planning. Recheck them as you travel so adjustments can be made to avoid trouble spots.
5. Traffic density. Select departure times to avoid heavy traffic near or around large cities.

SUPPLEMENTARY CONTENT:

Trip planning should also include the following vehicle checks for long-distance wear. Checks should be made both before and during the trip.

1. Check the condition and levels of all fluids, including oil, coolant, and fluids for the brakes, transmission, power steering, battery, and windshield washer reservoir. Add or replace fluid as necessary.
2. Check tire pressure (including that of the spare tire) when tires are cool. Add three to four extra pounds per tire for extra weight and high-speed driving. Check tire condition for wear and bad spots.
3. Inspect all fan belts and hoses and tighten or replace them as necessary.
4. Check wiper blades and replace them if worn or cracked.
5. Check the air filter and clean or replace it if necessary.
6. Clean and check the condition of headlights and check signals, brake lights, emergency flashers, and horn.

7. Equip the vehicle for emergency repairs and maintenance. Carry wrenches, various screwdrivers, pliers, a quart of oil, transmission fluid, brake fluid, an extra fan belt, windshield wiper blade, spare fuses, and a flashlight. Check the jack and lug wrench.

The load to be carried should be carefully planned for trips. Cargo and passenger weight have considerable effect on fuel economy. Every 100 pounds decreases fuel economy approximately one-tenth to one-half mile per gallon, depending on the vehicle model and the engine type.

Loads should be carried inside the vehicle as opposed to outside the vehicle. The more streamlined the vehicle the lower will be its drag against the wind and the better its fuel economy. Always select the right vehicle for the load and the trip.

4.3 Fuel-Efficient Alternatives

Objective: Identify travel alternatives that save time and fuel.

4.3.1 Discuss travel alternatives that can help the driver reduce time and fuel that are spent in travel. Use slide transparencies 27 and 28 to assist in the discussion.

BASIC CONTENT:

Although people habitually turn to the personal vehicle as the regular means of travel—and often as the only occupant of the vehicle—there are alternative travel means that can save both fuel and time.

SLIDE 27

1. Sharing rides. Not only can rides to work be shared (this is the traditional application of the term *ridesharing*), but rides can be shared for family business or social events. Sharing rides with others can:
   a. reduce the number of trips and miles traveled,
   b. save between $300 and $1000 a year on gasoline costs,
   c. save considerable wear and tear on the vehicle,
   d. reduce driving stress and frustration, and
   e. save parking spaces.

SLIDE 28

2. Using efficient short-distance alternatives. Whenever possible, use alternatives such as the following:
   a. Call ahead, arrange for deliveries, or use the mail. Using the phone in advance (for example, to determine that a store has an item in stock) can prevent wasted trips.
   b. Walk.
   c. Use a bicycle, moped, or motorcycle.
   d. Use public transportation, such as bus, subway, or train.
3. Investigating alternative long-distance travel methods. In some cases, it is more economical to travel by airplane, bus, or train and to rent a car at the destination.

SUMMARY: Lesson 4 may be summarized as follows using slide transparency 29:

SLIDE 29

Combine your trips + Plan the sequence + Select your route + Share rides + Use a fuel-efficient alternative = More Miles Per Gallon.

LESSON 5: Proper Vehicle Maintenance

Lesson Goal: Students will learn the importance of regular maintenance in increasing the fuel efficiency of a vehicle.

Lesson Overview: This lesson discusses the importance of regular vehicle maintenance and demonstrates that minor maintenance and inspection tasks can be done by the vehicle owner with a minimum of tools and training. The basic instructional approach is teacher-directed discussion with the assistance of slide transparencies.

Lesson Topics:

Suggested Learning Activities:

1. Ask the students to list the problems that can be caused by improper tire pressure. Compile the lists and make a master list for distribution to all students.
2. Ask the students to conduct a survey of twenty licensed drivers, asking them what adjustments should be made in tire pressure for (1) high speed driving, (2) heavy loads, and (3) winter driving. Compile the information and look for trends in how people maintain their tire pressure.
3. Invite a certified mechanic to discuss critical tune-up requirements. If there is an auto mechanics shop in your school, arrange to take the class there for instruction.
4. Ask each student to write an article about the relationship between automobile tune-ups and improved mileage. Select the best article and make it available to the community through the school paper, local newspaper, and leaflets.

Related Materials: 1, 2, 4, 5, 7, 8, 9, 14, 16, 20, 23, 25 (See Appendix A)

5.1 Proper Tire Care

Objective: Describe at least one way in which each of the following increases gas mileage: (a) proper tire pressure, (b) proper wheel alignment, and (c) tire rotation.

5.1.1 Discuss the effects of proper tire pressure on gas mileage, traction, and tire life. Use slide transparency 30 to highlight the discussion.

BASIC CONTENT:

Proper inflation is the key to tire safety, improved tire mileage, and fuel economy.

Recommended tire pressure is expressed as a range of pounds for each tire. Inflating to the minimum level of the range is insufficient for fuel economy. Real savings come from maintaining pressure at the highest level of the recommended range. For example, if the range is 24 to 28 pounds, tires should be inflated at 28 pounds.

SLIDE 30 Underinflated tires increase fuel usage. For every pound of pressure below the recommended range, fuel usage is increased two percent. Incorrect inflation also causes unnecessary tire wear and affects vehicle handling.

Overinflation also decreases the tread life of the tires. When overinflated, tires give a harder ride and are more vulnerable to damage.

Tire pressure should be checked every two weeks and before long trips or when carrying extra heavy loads. Check the pressure when the tires are cool because pressure can increase up to six pounds when tires are hot. Never lower the pressure before long trips or when the tires are hot.

SUPPLEMENTARY CONTENT:

According to data developed by the Federal Highway Administration (Spring 1979), Ohio drivers could save over 51 million gallons of gas yearly by keeping their tires properly inflated. Approximately one-fourth of all Ohio drivers travel with at least one tire four pounds below the recommended pressure level. Approximately 80 percent of Ohio drivers drive on tires that are either over- or underinflated by two or more pounds.

5.1.2 Discuss the importance of keeping wheels properly aligned.

BASIC CONTENT:

When a vehicle shimmies, bounces, wanders, or vibrates, it is likely that the wheels are improperly aligned or tires not balanced. Improper toe alignment causes front tires to roll at an angle, requiring extra power to overcome the improper alignment. Improper wheel alignment can increase fuel consumption by 0.3 miles per gallon. Improper alignment also results in faster tire wear. Having an annual check of balance and alignment is important for good fuel economy and tire life.

SUPPLEMENTARY CONTENT:

Excessively worn or damaged tires are a safety hazard. Tires should be inspected regularly for the following:

1. Stones, metal, or glass fragments in the tire grooves and sipes. Remove any objects before they work their way into the tire and damage it.
2. Abnormal tread wear, cuts, bulges, or other damage. Improper tire wear can occur quickly. The driver should be alert to road conditions and vehicle conditions (such as improper tire balance) that can cause damage and should check for damage frequently.
3. Wear. Wear bars are built into new tires. When they become exposed, the tread is worn to a sixteenth of an inch in the center grooves. A penny can also be inserted in the grooves to check tread depth. If the tread does not come up to the top of Lincoln's head, the tread is excessively worn.

5.1.3 Discuss the importance of rotating tires at proper intervals.

BASIC CONTENT:

Tire rotation is very important for maximum tire performance because it distributes wear on the tires and thereby lengthens the life of the tires. Better tread causes less tire resistance, which increases gas mileage. Rotation should be done every 6,000 to 8,000 miles. The first rotation is the most important because it sets the pattern of wear that the tires will maintain throughout their tread life. After rotation, tire pressure should be rechecked.

Tire rotation is not recommended for cars with front-wheel drive. A recent study has shown that rotation actually decreases tire tread life on these cars. On rear radial tires, nearly 100,000 miles of tread life can be expected by not rotating. (Check owner's manual for specific instructions.)

SUPPLEMENTARY CONTENT:

Tires of the same size and construction should be used on all four wheels. Replacement tires should be of the same size and type as the original tires. Radial tires should never be mixed with conventional bias or bias-belted tires; the differences in the way they perform make mixing them unsafe.

5.2 Minor Maintenance and Inspection Checks

Objective: Identify engine parts that should be checked at periodic intervals to increase the fuel efficiency of a vehicle.

5.2.1 Discuss the merits of conducting a regular preventive maintenance check on critical engine parts, emphasizing fuel economy and the prevention of costly repairs. Slide transparencies 31 and 32 may be used to assist in the discussion. Show examples of the parts being discussed if they are available.

BASIC CONTENT:

Proper vehicle maintenance improves fuel economy significantly and increases safety. The frequency of maintenance depends on driving habits, road conditions, and the kind of vehicle. Some vehicles, because of engine design, need more frequent minor maintenance inspection checks than others. The owner's manual should be consulted for frequency of inspection and parts to be checked.

The following items should be checked at periodic intervals on most vehicles.

SLIDE 31

1. Hoses, clamps, and connections. Hoses that are brittle or show signs of cracking should be replaced. Upper and lower hoses should be replaced at the same time because deterioration of one indicates potential deterioration of the others. Driving with damaged hoses can cause a burst or leakage, resulting in the loss of coolant and possible destruction of the engine through overheating.

2. Belts. Check for loose, frayed, or cracked belts, being careful to look at the undersides. Looseness will cause a belt to slip, which in turn causes such key components as the fan, alternator, water pump, and battery to either slow down or charge ineffectively, thereby affecting their performance.

   Belt tension is checked by pushing down on the middle point between the pulleys. If there is more than one-half inch of play, the belt should be tightened.

3. Coolant level. Check the level of the radiator fluid at frequent intervals to detect internal or external leaks. Check the radiator cap for signs of wear around the gasket.

   If the coolant is dirty or rusty (this usually occurs after two years), drain and flush the engine by opening the engine drain plugs as well as the radiator draincock. If only the draincock is opened, some of the old coolant may remain in the system. Draining should include flushing with a hose. Repair small radiator leaks by adding an antileak substance to the coolant.

4. Lubrication system. Check the oil level on a regular basis when the engine is cold. Place paper or cardboard under the vehicle to check for oil leaks.

   Dirty oil can seriously damage engine parts by causing friction and wear. This also decreases gasoline mileage. An important component in the lubrication system is the oil filter whose purpose is to prevent dirt from entering the internal parts of the engine The filter gradually becomes clogged with the dirt it has removed from the oil and should be replaced at the intervals recommended by the manufacturer.

   According to the Society of Automotive Engineers, a vehicle should not be driven more than 5,000 miles without a change of oil and oil filter. In dusty areas of the country, 3,000 miles is the maximum.

5. Battery terminals, cables, and connections. Check the battery for corrosion around the terminals and cable ends. This is one of the most often neglected parts of vehicle maintenance. A battery that is beginning to corrode should be cleaned.

   To clean the battery, remove it from the vehicle and use a wire brush to scrub it with a solution of baking soda and water. Rinse the battery completely before replacing it. Apply a light coating of grease to the terminals to discourage further corrosion.

6 Air filter. A clogged air filter decreases gas mileage. To check an air filter, remove it from its housing and try to see light through it (a trouble light, flashlight, or even sunlight is good for testing). If no light shines through, air won't come through. Clean or replace a dirty air filter immediately. The air filter should be replaced at least once a year or every 12,000 miles. In dusty areas, replace the filter earlier.

7. Fuel filter A clogged fuel filter will allow dirt in the fuel to enter the carburetor and narrow passages that are critical for the proper air-fuel mixture. Clean or replace a dirty fuel filter immediately. A fuel filter should be replaced at least once a year or every 12 000 miles.

8 Thermostat A defective thermostat can cause slow engine warm-up, which is a serious fuel waster, or failure to maintain economical running temperatures (engines work more efficiently at higher temperatures). Check with a mechanic for the correct replacement.

9. Exhaust system. Check for bends in the tail pipe and possible dents in the muffler. Such restrictions within the exhaust system can cause exhaust back-pressure, which in turn results in diminished horsepower, overheating, and high gas consumption

SUPPLEMENTARY CONTENT:

SLIDE 32

Grade of engine oil also affects fuel economy. Using an engine oil that is too thick, such as single grade SAE 30 oil, retards oil flow and increases the friction between engine parts. The more resistance an engine must overcome, the more fuel is used.

According to the viscosity classification system of the Society of Automotive Engineers, an oil with a high viscosity number is thicker than one with a lower number. For example, 40 oil is thicker than 10W oil. The "W" indicates that the oil is desirable for use in winter driving.

It is advantageous to use a combination oil that can be used continuously from one season to another. For example, a 10W-40 oil will have the viscosity of a 10W oil when the engine is cold and that of a 40 oil when the engine is warm.

Synthetic oils, or "antifriction" oils, which are designed to improve mileage, are also available.

5.3 Tune-up Requirements

Objective: Identify the purpose of regular tune-ups, ten signs that a vehicle needs a tune-up, and the major elements of a tune-up that are essential to good fuel economy and driver safety.

5.3.1 Explain the purpose of having engine tune-ups on a regular basis, using slide transparency 33.

BASIC CONTENT:

SLIDE 33 Certain tune-up requirements are absolutely critical to the fuel-efficient operation of a vehicle. A properly tuned vehicle can save fuel and costly repairs. For most vehicles, a simple tune-up will increase gas mileage by at least six percent. For a badly neglected vehicle, the improvement can be as much as 20 percent or more.

A person who services his or her own vehicle can save considerable money by avoiding the cost of labor at a repair garage and by paying discount prices for parts for which garages charge list prices. Some adjustments, however, are best left to a person who is mechanically knowledgeable or a certified mechanic. No amount of savings will compensate for damage to the engine caused by mistakes. Adult education courses can help prepare a person to do minor tune-ups.

SUPPLEMENTARY CONTENT:

Individuals who want to perform the tune-up on their vehicle need the following special tools and instruments:

1. set of screwdrivers
2. spark plug wrench (check the owner's manual for appropriate size)
3. set of combination wrenches (these are open on one end and boxed on the other)
4. feeler gauge to set the points
5. gap gauge to gap the plugs
6. timing light
7. tach/dwell meter
8. compression tester

5.3.2 Discuss ways a driver can tell when a tune-up or minor adjustments are needed. Emphasize the value of maintaining accurate records of fuel consumption to help in making this judgment.

BASIC CONTENT:

An accurate record of gas mileage should be kept because any changes in gas consumption may indicate changes in the vehicle's mechanical condition. A drop in gas mileage can indicate a problem.

Look for these telltale signs to indicate the need for a tune-up:

1. miles driven since last tune-up
2. hard starting
3. frequent stalling
4. rough idling
5. fast idling when warm
6. misfiring
7. poor acceleration
8. hesitation, especially when passing
9. knocking or pinging
10. rough running

When the exact cause of a problem is unknown, it may be helpful to take the vehicle to a diagnostic center where a series of tests can be performed. Learning the problems before taking the vehicle to be serviced can enable the car owner to give the mechanic some real guidance and to avoid unnecessary repairs.

SUPPLEMENTARY CONTENT:

Even when a vehicle is running well and has no apparent problems, periodic tune-ups are recommended. As a rule of thumb, an engine should be tuned at least every 10,000 to 12,000 miles. It should be noted that a tune-up is not a cure-all for engine problems. Overdependence on tune-ups can be wasteful and expensive.

5.3.3 Identify the major elements that are recommended for a major tune-up, emphasizing that the tune-up schedule recommended in the owner's manual should be followed carefully. Use slide transparency 34 to assist in the discussion.

BASIC CONTENT:

The following elements should be checked as part of a tune-up.

SLIDE 34

1. Spark plugs. Spark plugs gradually become fouled by combustion deposits, causing them to misfire. A misfiring plug can waste fuel at the rate of two miles per gallon. Spark plugs should be checked and cleaned periodically and regapped to specifications. Or they should be changed with each complete tune-up.

   Spark plug conditions to watch for include: (a) worn plugs (rounded electrodes), (b) carbon deposits (dry, sooty electrodes), (c) preignition (premelted electrodes), and (d) overheating (blistered, white insulators; eroded insulators).

2. Distributor cap and rotor. Check for cracks, carbon tracking, terminal erosion, and excessive wear of the center contact button. Any crack in the cap, even one that is almost invisible, is big enough to cause a short or erratic firing in moist weather. The rotor should be checked for damage or erosion of the contact tip. Both should be cleaned periodically or they should be replaced with each complete tune-up.

3. Electronic connections at the distributor, coil, and spark plugs. All connections should be clean and tight. Examine the spark plug wires for fraying, cracks, softness, and oil contamination.

4. Points and condensor. These should be checked when the spark plugs are checked. The points should be adjusted periodically or replaced with each spark plug change. The condensor should be replaced only if the points show abnormal pitting.

5. PCV valve. If the PCV valve becomes clogged, it will unbalance the combustion mixture. It can be easily checked. With the engine idling, place a finger over the opening at the bottom of the PCV valve. If you do not feel strong suction, the valve is clogged and must be replaced.

6. Choke. Check the choke for gumming and varnish that could build up. Remove the gum and varnish by spraying the choke with carburetor cleaner. (Note: An automatic choke that is not working correctly can waste fuel at the rate of three miles per gallon.)

7. Timing. Check the ignition timing according to the conditions and specifications in the owner's manual or on a label under the hood. (Note: For many drivers without experience at tune-ups and those without the appropriate equipment, this task is better left to a skilled mechanic.)

SUPPLEMENTARY CONTENT:

Keep accurate records of vehicle maintenance. Record all parts numbers. Record the date when the vehicle was tuned, the mileage at the time of the tune-up, and what repairs were made.

Maintenance records can be compared with the recommended maintenance schedule in the owner's manual to help the driver plan for future maintenance requirements.

To assist in vehicle maintenance, use the Problem Chaser Checklist on page 40 to identify and guard against potential problems.

SUMMARY: Lesson 5 may be summarized as follows using slide transparency 35:

SLIDE 35 — Regular scheduled maintenance checks + Periodic tune ups and adjustments + Accurate records of vehicle maintenance + Tires inflated to highest safe recommended pressures + High mileage oils = More Miles Per Gallon.

PROBLEM CHASER CHECKLIST

Drivers can learn what clues are provided by their vehicles when mechanical problems occur. By determining what the problem is and how long it has been happening, valuable information can be obtained which will prevent waste of fuel and result in more fuel-efficient driving.

STARTING CAR	THE ENGINE	TURNING THE ENGINE OFF	STEERING CAR, BRAKING, OR STOPPING	GAUGES, HEATING, COOLING, OR DEFROSTING
WHAT'S HAPPENING?				
☐ Car "clicks" when turning the key, but won't start	☐ Engine races wildly	☐ Engine keeps on running	☐ Car wanders left/ right	☐ Oil lamp is on
☐ Starter runs when turning the key, but the car won't start	☐ Engine backfires	☐ Engine backfires	☐ Steering wheel shakes	☐ Oil pressure gauge is low
☐ Car seems like it's trying to start but won't	☐ Engine won't idle	☐ Ticks or clacks	☐ Steering wheel jumps up and down	☐ Temp lamp is on
☐ Car starts, but dies	☐ Engine coughs and sputters		☐ Grinding noise from wheel area when moving	☐ Alternator lamp is on
	☐ Engine has no pep		☐ Car pulls left/right	☐ Alternator is discharging
	☐ Speeds up when transmission shifts		☐ Brake pedal goes almost to floor	☐ Gas gauge doesn't register
	☐ Engine surges		☐ Grinding noise when brakes are applied	☐ Speedometer needle doesn't move
	☐ Ticks or clacks		☐ Car is difficult to stop	☐ Brake light is on
	☐ Loud roar when running			☐ Steam from under the hood
				☐ Heater doesn't work in cold weather
				☐ A/C doesn't work in hot weather
WHEN DOES IT HAPPEN?				
☐ In the morning	☐ In the morning	☐ After the car has warmed up	☐ In cold weather	☐ In cold weather
☐ In cold weather	☐ In cold weather	☐ Especially in hot weather	☐ In hot weather	☐ In hot weather
☐ In hot weather	☐ In hot weather	☐ Only in cold weather	☐ In wet weather	☐ In wet weather
☐ In wet weather	☐ After driving a few miles	☐ After driving for only a few minutes	☐ After driving through puddles	☐ After driving a few miles
☐ When it's been raining all night	☐ After driving the car for 30 minutes or longer		☐ Only at certain speeds	☐ After driving the car for 30 minutes or longer
	☐ Only at certain speeds		☐ While cruising	☐ While cruising
	☐ While accelerating		☐ While idling	☐ While idling
	☐ While decelerating		☐ While accelerating	☐ While accelerati
			☐ While decelerating	☐ After ignition i turned off
HOW LONG HAS IT BEEN HAPPENING?				
☐ Just happened today	☐ Just happened today	☐ Just happened today	☐ Just happened today	☐ Just happened today
☐ Off and on	☐ Off and on	☐ Off and on	☐ Off and on	☐ Off and on
☐ Infrequently	☐ Infrequently	☐ Infrequently	☐ Infrequently	☐ Infrequently

Information adapted from [illegible], May 3, 1979, p. E-8. with permission.

LESSON 6: Practicing Fuel-Efficient Driving

Lesson Goal: Students will put into practice the safe and fuel-efficient driving techniques that were discussed in the previous lessons.

Lesson Overview: This lesson provides students the opportunity to practice fuel-efficient driving techniques. Each student will be evaluated on a planned driving route as to how well he or she demonstrates these techniques in actual driving situations.

Lesson Topics:

Suggested Learning Activities:

1. Using a map of the practice driving route, ask each student to plan pretrip strategies based on his or her (1) knowledge of fuel-efficient driving techniques and (2) familiarity with the important characteristics of the route.
2. Using a planned driving route, ask each student to demonstrate his or her ability to drive in a fuel-efficient way. Use the Sample On-Road Situations Evaluation form (page 54) and discuss the results with each student when the evaluation is completed.

6.1 Teacher Preparation

Objective: (There is no student objective for this section.)

6.1.1 Select a driving route that includes at least 18 to 24 check points and check areas.

BASIC CONTENT:

Teaching students how to apply energy-efficient driving techniques and to form habits of these techniques in the in-car phase will require some practice and planning. It is suggested that a route be planned over which students can drive and practice fuel-efficient driving techniques. The same route will be used to evaluate students' performance of techniques learned in previous lessons.

The route should include at least 18 to 24 check points and check areas, as defined below:

1. Check point: A specific location on the route where the teacher or student observers evaluate a designated response (for example, speed selection approaching an intersection).
2. Check area: A segment of roadway, which can vary in length from one block to several blocks, where the teacher or student observers evaluate a designated response (for example, establishing and maintaining a safe following distance).

Five response categories are to be evaluated and should be included in the check points and check areas. These responses are listed below along with examples of situations that could elicit the desired responses. The responses and situations are shown on the Sample Route Map, page 43, as 1, 2a, 2b, and so on.

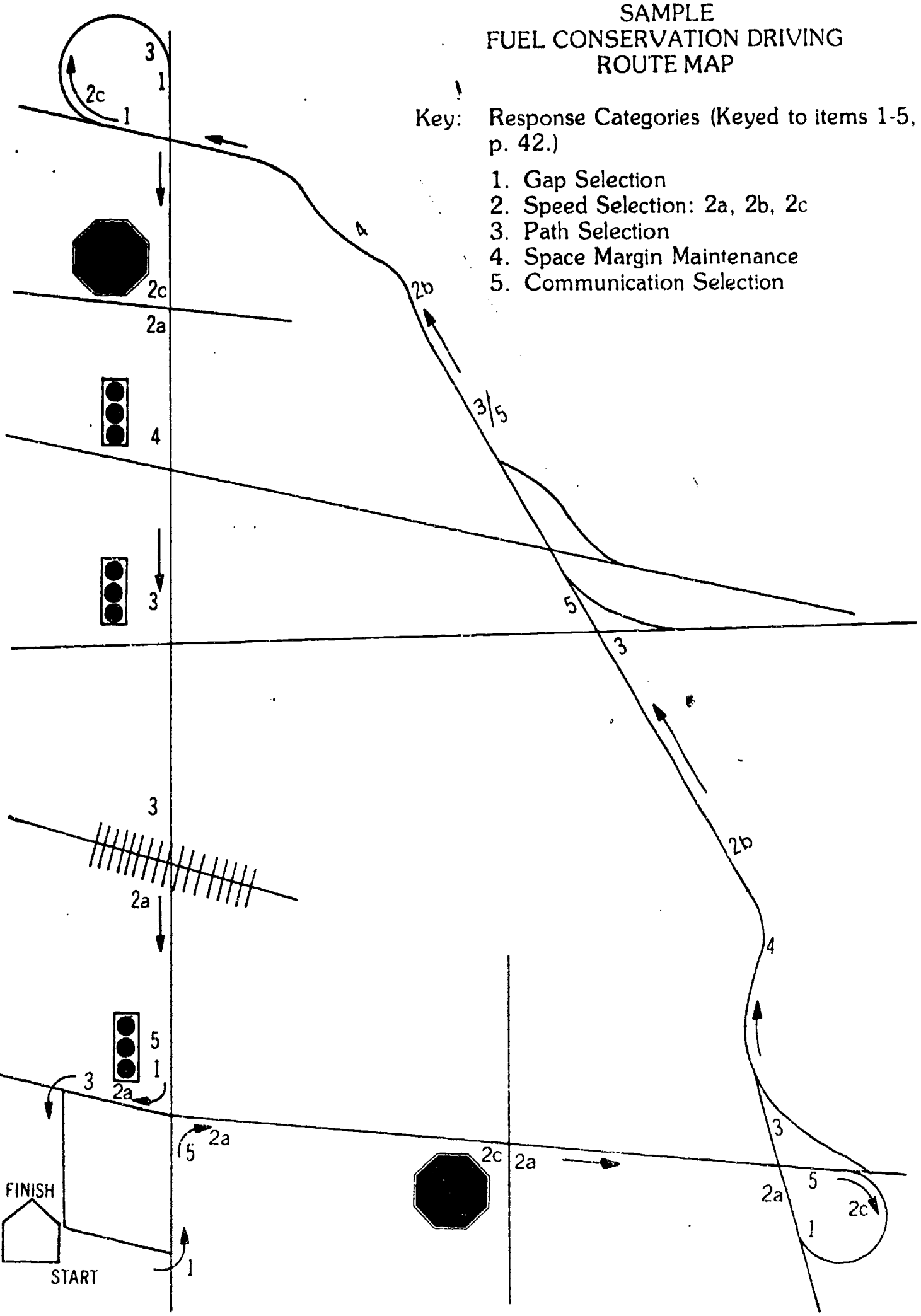
1. Gap selection: Entering, exiting, merging, and turning
2. Speed selection
   a. Accelerating quickly and smoothly
   b. Maintaining steady speed
   c. Braking smoothly to stop vehicle
3. Path selection: Adjusting to roadway and traffic conditions
4. Space margin maintenance: Establishing and maintaining proper following distance (two seconds)
5. Communication selection: Communicating all intentions early (turning, stopping, passing, merging)

Review the route map with the students, pointing out the responses sought at each check point and check area. The route can then be used as often as desired for practice driving before evaluation takes place. Give Appendix D, 33 Important Fuel Saving Tips (pages 52-53), to the students to review important fuel-efficient driving techniques. After each fuel-efficient driving technique, the illustrated performances or maneuvers in the parentheses identify locations where the specific driving technique is necessary to achieve the best fuel economy and safe driving.

SAMPLE
FUEL CONSERVATION DRIVING
ROUTE MAP

Key: Response Categories (Keyed to items 1-5, p. 42.)

1. Gap Selection
2. Speed Selection: 2a, 2b, 2c
3. Path Selection
4. Space Margin Maintenance
5. Communication Selection



6.2 Evaluating Student Performance

Objective: Demonstrate fuel-efficient driving techniques on a planned driving route.

6.2.1 Use the Sample On-Road Situations Evaluation form (Appendix E, page 54) to evaluate the students' performance on the planned driving route.

BASIC CONTENT:

Have each student drive the planned route using the fuel-efficient driving techniques learned in previous lessons. Evaluate their performance as described below.

The role of the teacher in the on-road evaluation includes giving instruction, providing necessary direction, and evaluating student performance. Student observers can also serve as evaluators during the on-road situations evaluation.

Using the Sample On-Road Situations Evaluation form in Appendix E, score responses in all situations (check points and check areas) as being either "conserving" or "wasteful" driving techniques. All the items are easy to score: either the student made the appropriate response or did not.

Give one positive point for each conserving technique item circled and one negative point for each wasteful technique item circled.

The types of situations that elicit the behaviors sought should be comparable for all student drivers. However, the driving conditions may vary, making the number of situations different from student to student. Therefore, the total score should be based on the proportion of situations handled successfully (wasteful scores subtracted from conserving scores).

SUPPLEMENTARY CONTENT:

Conduct a fuel-economy contest in which the students can demonstrate that the way they drive affects the amount of fuel they use.

With media support, a fuel economy contest can have a tremendous motivational effect in the community, making citizens aware that good driving techniques and proper vehicle maintenance can reduce the impact of the energy crisis by saving fuel. In addition, the contest provides parents an opportunity not only to experience what their children have learned, but to learn and adopt energy-efficient driving techniques and habits themselves.

Route Selection:

Select a route to fit your needs in terms of time and location. If possible, the route should include the following:

1. residential (low density) area
2. city (heavy density) area

3. rural highway
4. freeway

As noted in items 3 and 5 under "Suggested Contest Rules," a service station and a place where vehicles can be weighed should also be included.

If time allotment is to be used as part of the contest, have several teachers drive the route before the contest, observing posted speed limits during different times of the day.

Once the route is finalized, develop a log of the route, including the following:

1. descriptions of all the roads, in order of usage
2. direction and turns \
3. check points
4. distances between points
5. total driving distance
6. estimated time schedule

Suggested Contest Rules:

1. Eligibility. All participants must possess a valid State of Ohio temporary driver's license or operator's license. Students must be enrolled in a current high school driver education program.
2. Starting time. Have each entrant report with his or her vehicle at the starting point (designated location or service station) with one or both parents at the time designated.

   Provide contestants with a copy of the route map and suggest that they mark the planned route before starting. Explain to all contestants that they must follow the log for the entire contest route. Leaving the planned course will result in disqualification.

   Point out that all rules and regulations governing traffic as published by the State of Ohio, municipality, or other civil authority must be observed.

   Identify all participating vehicles with a conspicuous vehicle number and any other appropriate decal or sign.
3. Fueling. All vehicles should be fueled at a chosen service station immediately prior to the contest. Once fueled, have each contestant bring his or her vehicle to the starting point. The engine should not be started until the driver is instructed to do so by the contest starter. Upon finishing the contest, each contestant should turn his or her engine off, have the vehicle refueled, and move to the parking area. After recording the amount of fuel added and driving time (if used), the observer should submit his or her report to the head official.

4. Vehicle inspection. Inspect the following components of all vehicles prior to the contest:
   a. intake fuel system (pump, carburetor, and intake manifold)
   b. ignition system (distributor, wiring, and spark plugs)
   c. exhaust system (exhaust manifold, muffler, and tail pipe)
   d. horn
   e. lights (headlights, turn signals, brake lights, and emergency flashers)
   f. tire pressure (to recommended levels)
5. Vehicle weight. Plan the route to include a location where the cars can be weighed. If desirable, make the location one of the check points along the contest route. Weigh each vehicle, including spare tire, normal tire changing equipment, driver, and observer.
6. Rating. Rate each vehicle finishing the contest according to gasoline consumption (amended by penalties, if any—see item 8), in ton-miles per gallon. This formula compensates for the total weight that is moved in determining economy. That is, multiply the vehicle weight (in tons) times the length of the course (in miles) and divide by the amount of fuel used (in gallons)—(Tons x Miles ÷ Gallons = Rating). For example, if a vehicle weighs 2,000 pounds, or one ton, and travels a 60-mile course on exactly two gallons of gasoline, it will receive a rating of 30.00 ton-miles per gallon (1 x 60 ÷ 2 = 30.00).
7. Observers. Each observer should be a licensed adult not related to the driver.
8. Penalties. Assess penalties for any violations of fuel-efficient driving techniques or habits. (See Sample Observer's Report and Record Sheet, Appendix F, page 55.)
9. Disqualification. The disqualifying actions noted on the Observer's Report disqualify the entrant. Failure to meet the time limits (if established) should disqualify the contestant; however, time lost because of delays that are not the fault of the contestant may, in the judgment of the observer, be deducted from the contestant's total time.

Suggestions for Vehicle Use:

1. Driver education cars. The number of participants, the length of the route, and the duration of the contest will depend on the number of cars available. To increase the number of participants, each class can select several teams (for example, groups of four). With driver education teachers serving as the observers, each team member drives a specific section of the proposed route (similar to a relay race). This format can be repeated several times during the day, using the same route, and results in a highly competitive contest. Awards are then given to teams and classes with the best overall records.

2. Dealer sponsored cars. With driver education teachers serving as observers, have the better student drivers from different classes or schools (sponsored by various automobile dealers) drive over the proposed contest route. Prizes, sponsored by the dealers, are awarded to the winners. This method usually results in excellent publicity, but it is likely to result in fewer participants.

3. Personal or family vehicles. Use of personal or family vehicles provides the greatest number of student and parent participants. Requirements: (1) Vehicles must be stock for the year and model. (2) Parents participate as observers (not in their own cars). (3) All vehicles are properly insured prior to the contest.

   Each participant drives the proposed test route with the parent serving as the observer for another vehicle in the same time slot.

APPENDIXES

A. RELATED MATERIALS

1. *A Guide to Buying Tires and Batteries*

   Gulf Oil Corporation
   1025 Connecticut Avenue, N.W.
   Washington, D.C. 20036

2. *Champion's Guide to an Easy Car Tune-Up*

   Champion Spark Plug Company
   P.O. Box 900
   Toledo, Ohio 43661

3. *Common Sense in Buying a New Car*

   Office of Public and
   Consumer Affairs
   U.S. Department of Transportation
   Washington, D.C. 20590

4. *Consumer Tire Guide*

   Tire Industry Safety Council
   Suite 766, National Press Building
   Washington, D.C. 20045

5. *Don't Be Fuelish*

   Federal Energy Administration
   Washington, D.C. 20461

6. *Driver Education Saves Gas*

   American Automobile Association
   Traffic Engineering and Safety
   Department
   8111 Gatehouse Road
   Falls Church, Virginia 22042
   or
   Local AAA Club

7. *Energy Fact Sheet*

   Cooperative Extension Service
   The Ohio State University
   Columbus, Ohio 43210

8. *Facts on Car Care*

   Firestone Sales Training
   Department
   1200 Firestone Parkway
   Akron, Ohio 44317

9. *Gas Watchers Guide*

   American Automobile Association

10. *Get More Missouri Per Gallon*

    Missouri Department of Natural
    Resources
    P.O. Box 176
    Jefferson City, Missouri 65102

11. *Happiness Is a Full Tank*

    American Driver and Traffic Safety
    Education Association
    1201 Sixteenth Street, N.W.
    Washington, D.C. 20036

12. *How Smart Drivers Save Gasoline*

    Mobil Oil Corporation
    150 East 42nd Street
    New York, New York 10017

13. *How to Save Gasoline...and Money*

    Ohio Department of Energy
    30 East Broad Street
    Columbus, Ohio 43215

14. *How to Save Your Car (and Gasoline)*

    Ethyl Car Care Booklet
    P.O. Box 55665
    Houston, Texas 77055

15. *Shopping for That Fuel Economy Car*

    Society of Automobile Engineers
    Inc.
    400 Commonwealth Drive
    Warrendale, Pennsylvania 35096

16. *The Breakdown Book, The Early Warning Book, The Gasoline Book, The Self Service Book, The 100,000 Mile Book*

    Shell Oil Company
    P.O. Box 61609
    Houston, Texas 77208

17. *The Car Buying & Selling Book*

    Shell Oil Company

18. *The Energy Book*

    Shell Oil Company

19. *The Gasoline Mileage Book*

    Shell Oil Company

20. *The Road To Conservation*

    Atlantic Richfield Company
    515 South Flower Street
    Los Angeles, California 90071

21. *The Save Way to Drive*

    National Safety Council
    425 North Michigan Avenue
    Chicago, Illinois 60611

22. *Tips for Energy Savers*

    U.S. Department of Energy
    "Tips" Distribution
    Office of Administrative Services
    Washington, D.C. 20545

23. *You Can Do It Yourself and Save*

    Nationwise Auto Parts
    Local Retail Stores

24. *Your Driving Costs (1980 Edition)*

    American Automobile Association

25. *16 Steps to Conserve Energy on North Carolina Highways*

    North Carolina Energy Division
    P.O. Box 25349
    Raleigh, North Carolina 27611

26. *1980 Gas Mileage Guide*

    Fuel Economy
    Consumer Information Center
    Pueblo, Colorado 81009

27. *55—How to Live With It*

    General Fred W. Vetter, Jr.
    2201 Federal Building
    300 South New
    Dover, Delaware 19901

28. *55 MPH Saves*

    Texas Office of Traffic Safety
    State Department of Highway and
    Public Transportation
    Austin, Texas 78711

Films:

29. *Driving Economically...It's Up To You* (1978) 16 mm, 15 min.

    Modern Talking Picture Service
    New Hyde Park, New York 11040

30. *Running on Empty* (1978) 16 mm, 28 min.

    Ohio Department of Energy

31. *Who Cares* (1980) 16 mm, 21 min. Rental or purchase.

    Visucom
    P.O. Box 5472
    Redwood City, California 94063

32. *Working Together to Conserve Energy* (1976) 16 mm, 14 min.

    Walter J. Klein Company
    6301 Carmel Road
    Charlotte, North Carolina 28211

Filmstrip:

33. *The Drive for Conservation Educational Program* (1979) 20 min.

    Atlantic Richfield Company
    Public Affairs, Room 1619
    P.O. Box 2679—Terminal Annex
    Los Angeles, California 90051

B. FUEL ECONOMY SAVINGS*

If you take the steps in this column	...you can save the equivalent of this much on each gallon of gasoline.	Percentage savings per gallon
PURCHASE DECISION		
Buy a vehicle that gets 10 MPG more than a current vehicle.	$.22	17.6
Buy radial tires.	.03	2.4
BEHIND-THE-WHEEL TECHNIQUES		
Warm engine correctly. Accelerate quickly and smoothly. Drive at moderate speeds. Anticipate traffic, maintain space margin. Flow smoothly with traffic.	.06	5.0
TRIP PLANNING		
Share rides.	.11	8.8
Combine trips.	.06	5.0
VEHICLE MAINTENANCE AND CARE		
Have regular tune-ups and adjustments.	.05	4.0
Inflate tires to highest safe recommended pressures.	.04	3.2
Use high mileage oil.	.03	2.4
YOU CAN SAVE:	.60 per gallon	48.4

* The savings are based on a gasoline price of $1.25 and assume that all of these items are accomplished together. Information adapted from the U.S. Department of Energy Driver Awareness Program, Driver Energy Conservation Awareness Training (DECAT).

C. GAS MILEAGE WORKSHEET

LONG WEEKEND TRIP

A trip was made from Cleveland, Ohio to Cincinnati, Ohio and back with several stops along the way. All of the driving was on interstate highways. The mileage was taken from the odometer at the beginning and end of the trip. The amount of gas and the cost were recorded as follows after each fill-up.

Miles Per Gallon: Miles ÷ Gallons = MPG. Cost Per Mile: Price ÷ Miles = CPM.

Odometer Readings: Beginning 11,263.0
End 12.143.0

Fuel Fill-ups	Cost*	Gallons
Cleveland, Ohio	$ 8.25	6.9
Cincinnati, Ohio	$12.00	10.0
Dayton, Ohio	$ 8.40	7.0
Cleveland, Ohio	$ 6.60	5.4

* Price of gasoline averaged $1.20 per gallon for leaded regular.

Questions:

1. How many miles were traveled for the entire trip?
2. What was the total cost?
3. How many gallons of gasoline were purchased?
4. What was the average miles per gallon (mpg)?
5. What was the average cost in cents per mile (cpm)?
6. How many hours were spent driving at an average speed of 55 miles per hour?

CORRECT ANSWERS: (1) 880 miles (2) $35.25 (3) 29.3 gallons (4) 30.0 mpg (5) 4.0 cents per mile (cpm) (6) 16 hours

D. 33 IMPORTANT FUEL-SAVING TIPS

VEHICLE SELECTION

1. Buy your next vehicle on the basis of the combination purchase price and estimated fuel costs.
2. Consider buying a lighter vehicle.
3. Purchase a vehicle with a fuel-efficient engine.
4. Avoid unnecessary purchase of power options and accessories.
5. Consider buying radial tires.
6. Consider buying a light-colored vehicle with light-colored interior.
7. Consider buying such fuel economy options as overdrive, fuel injection, and electronic ignition.

FUEL-EFFICIENT DRIVING TECHNIQUES

1. Accelerate quickly and smoothly (when leaving all signalized and controlled intersections and after turns, railroad crossings, and sharp curves).
2. Run through the lower gears gently and quickly for minimum fuel consumption (at similar locations as indicated above).
3. Drive at moderate speeds (in urban and suburban traffic).
4. Maintain steady speeds (on freeways, divided four-lane highways, and rural two-lane highways).
5. Observe the 55 mph speed limit (in similar situations as in number four).
6. Avoid unnecessary braking by anticipating traffic conditions ahead (congested traffic, large vehicles, parked cars, school zones, heavy pedestrian traffic, and where sight distance is reduced by obstructions).
7. Avoid excessive idling (at railroad crossings, traffic jams, loading zones, and waiting in long lines).
8. Avoid fuel-wasting habits (pumping the accelerator to start vehicle, racing the engine, using the accelerator to hold the vehicle in stopped position, and excessive idling when warming up the vehicle).
9. Avoid unnecessary use of air-conditioning equipment (in heavy, congested traffic and sustained, high-speed driving).

10. Do not overaccelerate on a hill (when climbing hill, approaching crest of hill, and descending hill).

11. Do not tailgate (establish and maintain safe following distance in accordance with existing conditions and anticipate the need for lane changes in advance).

TRIP PLANNING

1. Plan short trips carefully. Drive slowly for the first few miles after a cold start.

2. Combine short shopping and commuting trips to reduce the number of miles traveled.

3. Plan trips by figuring out which route will require the least fuel.

4. If more than one vehicle is available, make the greatest use of the vehicle that consumes the least fuel.

5. Eliminate unnecessary trips. Use an efficient alternative.

6. Join a car pool. Share rides.

7. Do not carry unnecessary weight.

VEHICLE MAINTENANCE

1. Keep the engine tuned. Check the specifications given in the owner's manual.

2. Keep a record of miles per gallon.

3. Change oil and oil filter at recommended intervals.

4. Use gasoline of the proper octane rating.

5. Check tire pressures regularly. Inflate tires to the highest safe recommended pressures.

6. Make sure the wheels are properly aligned.

7. Keep the air filter and fuel filter clean.

8. Wax the vehicle to lower surface air resistance.

E. SAMPLE ON-ROAD SITUATIONS EVALUATION

STUDENT NAME_____ DATE_____

ENVIRONMENTAL FACTORS
Weather Conditions: CLEAR / RAIN / SNOW
Roadway Conditions: CLEAR / WET / SNOW COVERED
Traffic Conditions: LIGHT / MODERATE / HEAVY

FINAL SCORE
Conserving: _____
—Wasteful: _____
= _____

Directions: Circle the number of times the driver either CONSERVED or WASTED fuel during the evaluation.

CONSERVING TECHNIQUE	WASTEFUL TECHNIQUE	NUMBER OF RESPONSES
1 Properly enters, exits, merges, turns		1 2 3 4 5
	Improperly enters, exits, merges, turns	1 2 3 4 5
2a Accelerates quickly and smoothly		1 2 3 4 5
	Accelerates improperly (jack rabbit; too slow)	1 2 3 4 5
2b Maintains steady speed		1 2 3 4 5
	Fluctuates speed (too fast: too slow)	1 2 3 4 5
2c Brakes smoothly to stop vehicle		1 2 3 4 5
	Brakes hard to stop vehicle	1 2 3 4 5
3 Adjusts to roadway and traffic conditions		1 2 3 4 5
	Fails to adjust to existing conditions	1 2 3 4 5
4 Maintains proper following distance		1 2 3 4 5
	Tailgates	1 2 3 4 5
5 Communicates all intentions early		1 2 3 4 5
	Fails to signal intentions	1 2 3 4 5

F. SAMPLE OBSERVER'S REPORT AND RECORD SHEET*

STUDENT DRIVER_____ OBSERVER_____
(please print) (please print)

VEHICLE NUMBER_____ MAKE_____ MODEL_____ YEAR_____

TO BE RECORDED BY OBSERVER DURING CONTEST ROUTE. . .

PENALTIES — Place a check (√) in the appropriate boxes.

SAFETY VIOLATIONS	Violates stop light or stop sign	
	Exceeds posted speed limit	✓
	Fails to signal intentions	✓
	Fails to yield right-of-way	
WASTEFUL TECHNIQUES	Jack rabbit start (flooring)	
	Fluctuates speed	✓
	Tailgates	✓
	Brakes hard to stop vehicle	
	Idles unnecessarily	

TOTAL PENALTIES: 4

TIMES 1/10th EQUALS TOTAL PENALTY GALLONS: .4

DISQUALIFYING ACTIONS	Deviates from course	
	Refuels on course	
	Exceeds maximum time limit	
	Drives recklessly	

UNAVOIDABLE DELAYS — Cause_____

Time at start of delay_____ At End_____ Total Delay Time_____

Starting Time_____ Finish Time_____ Total Time_____

Odometer readings: Start_____ Finish_____ Total Miles_____

Gallons to Refuel: 2.60 + Penalty Gallons: .4

Weight: 2500 — Divided by 2000 lbs. for weight in TONS

Official Miles: 64.0 ÷ = Corrected Gallons + MPG: 3.00 = 21.33 × 1.25

OFFICIAL RESULTS TON-MPG: 26.66

*Information adapted from Mobil Oil Corporation.

G. KNOWLEDGE TEST

Circle the letter representing the correct answer.

1. Increasing the speed of the car increases wind resistance, which in turn will increase gasoline consumption. (a) true (b) false.

2. A clogged air filter causes the engine to use more gas and less air. (a) true (b) false.

3. Pumping the accelerator after starting the engine helps the car warm up more rapidly. (a) true (b) false.

4. Radial tires give better gas mileage than bias tires because they can be inflated to a higher recommended pressure. (a) true (b) false.

5. In warm weather, it is best to underinflate tires because warm temperatures will cause heat build-up. (a) true (b) false.

6. In cold weather, a car should be warmed up about five minutes before driving. (a) true (b) false.

7. A tire pressure check for over- and underinflation is needed four times a year, at the beginning of each season. (a) true (b) false.

8. An oil change from conventional motor oil to recently developed friction-reducing motor oils can help to conserve gasoline. (a) true (b) false.

9. Waxing a car lowers surface air resistance and aids in achieving better fuel economy. (a) true (b) false.

10. The short trip to the grocery store increases gasoline consumption significantly. (a) true (b) false.

11. What percentage of all petroleum products is used by passenger automobiles in the United States? (a) 14% (b) 26% (c) 50% (d) 75%.

12. The EPA *Gas Mileage Guide* tells (a) the type of gasoline recommended for various cars (b) the average miles per gallon one can expect from various cars (c) the expected life in miles of the average car (d) the effect of environmental concerns on gasoline consumption.

13. When evaluating transportation needs, which of the following should be considered? (a) the climate of the area (b) traffic density in places usually traveled (c) vehicle capacity and space requirements (d) all of the above.

14. What are the two most important fuel economy factors to consider when purchasing a new car? (a) vehicle weight and engine size (b) engine size and transmission (c) vehicle weight and tire tread (d) types and designs of options.

15. Your most recent odometer reading was 28355. The previous reading was 28080. You bought 11 gallons of gas to replace what you used up. What is your mpg? (a) 22 (b) 25 (c) 27 (d) 29.

16. What is the best way to accelerate? (a) jackrabbit style (b) gradually (c) smoothly and quickly (d) none of the above.

17. To save fuel, you should shut off the engine if you are going to idle (a) any time at all (b) more than 20 seconds (c) more than one minute (d) more than two minutes.

18. When approaching a hill, you should (a) accelerate early to build up speed (b) maintain momentum with continuous acceleration (c) ease off the accelerator (d) accelerate gradually.

19. The most fuel-efficient way to cool a car on the open highway is to (a) turn on the heater fan but not the heat (b) open the side windows completely (c) turn on the air conditioner to low (d) none of the above.

20. What are the advantages of planning ahead? (a) It helps establish shorter planned routes. (b) It eliminates unnecessary driving. (c) It eliminates cold starts. (d) All of the above.

21. Why does excessive idling waste fuel? (a) It results in zero mpg. (b) Engine resistance is reduced significantly. (c) A leaner fuel mixture is needed. (d) All of the above.

22. When is the best time to check tire pressure? (a) when the tires are cold (b) after a long trip (c) at a service station (d) when the car is fully loaded.

23. Tire rotation is done to (a) equalize the wear on all tires (b) keep the best tires on the front (c) provide a smoother ride (d) all of the above.

24. Identify the false statement about tire pressure: (a) Hand gauges are usually most accurate. (b) Tire pressure should be lowered in the winter. (c) Tire pressure should be raised for heavy loads. (d) Tire pressure increases during long trips.

25. Which of the following does not produce better gas mileage? (a) changing oil filter regularly (b) checking and gapping points and plugs (c) keeping wheels aligned (d) adding weight to the rear of the car.

CORRECT ANSWERS: (1) a (2) a (3) b (4) b (5) b (6) b (7) b (8) a (9) a (10) a (11) b (12) b (13) d (14) a (15) b (16) c (17) c (18) a (19) c (20) c (21) a (22) a (23) a (24) b (25) d

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