UNIT 2
MAINTENANCE AND OPERATION
4-H
AUTOMOTIVE PROJECT IN CARE AND SAFETY

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OUTLINE OF UNITS

You are invited to participate in the 4-H Automotive Program which has been developed especially for older Club members. Its purpose is to help you achieve and enjoy the fullest opportunities as a safe and efficient automobile driver, upon acquiring a license. The impact of the automobile age on our lives makes it important that we have more educational opportunities to learn the safe care and operation of automobiles.

Even though you have not started to drive as yet, the 4-H Automotive Project offers you an opportunity to share with others in your age group the advantage of learning more about the automobile, how it should be handled on the road, and the cost involved.

Following is an outline of the contents of the three Units, this manual being Unit II.

UNIT 1: The Car and the Highway
Section I. You and the Automobile
Section II. Highway Safety.
Section III. Group Activity—Highway Hazard Hunt.
Section IV. What Makes a Car Go! and Stop!
Section V. The Engine in General—Simple Principles of Internal Combustion.
Section VI. Carkeeping.
Section VII. Car Costs and Record Keeping.
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UNIT 2: Maintenance and Operation
Section I. The Engine as a Power Unit.
Section II. The Engine Needs Clean Air.
Section III. How the Fuel System Works.
Section IV. Igniting the Air-Fuel Mixture.
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UNIT 3: Operating the Car Efficiently
Section I. What Does It Cost to Own and Operate a Car?
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Section III. What Makes for a Smooth, Safe Ride.
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Section VIII. How to Make Your Community a Safer Place to Drive.
Section IX. Group Activities—Economy Run and Driving Skill.
The engine is the heart of an automobile. The strength of an engine is measured in terms of Horsepower (HP). The goal of this section of the 4-H Automotive Care and Safety Project is to help you understand horsepower and its meaning to you as you become a driver, and to provide you with an opportunity to know the engine parts and their functions. This knowledge will aid you in taking care of the most important part of an automobile — the Power Unit.

From the birth of the automobile industry the term horsepower has been used to indicate the ability of an engine to propel a car with the performance expected of it by the purchaser.

The scientist knows that power is the rate of doing work. Almost 200 years ago a man named James Watt wanted to rate a steam engine in terms of power. He observed that the average horse traveled at the rate of 2½ miles per hour (MeP.H.), or 220 feet per minute, and could exert a force of 150 pounds. As work is force times distance, 150 lbs. x 220 ft. = 33,000 ft. lbs., and since this work was done in one minute, it was a rate of doing work. James Watt called this amount of work "one horsepower." The term has been used since his day.

The advertised horsepower of an automobile is the Maximum or Gross Horsepower, which is obtained from a stripped engine on a test block. This method of rating the horsepower, automobile manufacturers agree, is not a very good overall measurement of the car's ability, but it is the best method that has been devised so far. All manufacturers use the same method.

To obtain the Gross Horsepower rating the air filters, fan, generator, and muffler are removed from the engine before it is placed on the test block. The engine is operated with a manually adjusted spark and without exhaust heat being applied to the intake manifold. The gross horsepower which occurs at a fairly high engine speed, is measured on a machine called a dynamometer, then corrected to a standard atmosphere according to the code of the Society of Automotive Engineers (SAE).

The reason the gross horsepower is used to rate an engine is because different models of cars, all with the same engine, may carry different power-absorbing equipment and accessories so that the power delivered to the rear wheels may not be the same from model to model.

When the engine is installed in a car, the manifold heat, the automatic spark, the generator, fan, muffler, and air filters all reduce the gross horsepower. Accessories such as power steering and air conditioning reduce it still further. Thus in a 250 gross horsepower car, equipped as described, about 135 horsepower actually is delivered to the flywheel. Additional power is lost through the transmission, drive line and rear axle so that the net power delivered to the rear wheels amounts to about 125 horsepower, or about 5/8ths of the rated gross horsepower of the engine.

More power is required to overcome air, tire and road resistance and chassis friction, with the result that the horsepower of the engine when the car is moving at any constant speed on a smooth, level, paved road would be something less than 120. This is further reduced when the car is operating at high altitudes or in conditions of extreme heat and humidity.
What's in the Power Unit?

For a power unit to deliver horsepower to the wheels over a long period of years, the materials used in building the engine must be carefully selected for the work each part will perform. These parts are machine ground and polished to a precision fit, one with the other, so as to give a powerful, smooth-running engine.

The cylinder block, crankcase and cylinder head form the foundation and main stationary body of the automobile engine and serve as support and enclosure for moving parts.

The CYLINDER BLOCK contains: (1) the smooth, round cylinders in which the pistons slide up and down; (2) the openings for the valves or push rods, and (3) the passages for the flow of cooling water. The cylinder surfaces are given a precision mirror finish by an accurate grinding and honing process. In nearly all modern day automobile engines the cylinders are cast in a single block, although removable liners of special hardened steel sometimes serve as cylinder walls.

The CRANKCASE acts as the base of the engine. It supports the crankshaft and camshaft in suitable bearings and provides arms or brackets for supporting the engine on the frame. Although the cylinder block and the crankcase must be considered as separate parts from a functional standpoint, physically the cylinder block and the upper half of the crankcase usually are cast as a single unit. The combined cylinder block and crankcase casting usually extends a short distance below the center line of the crankshaft. This casting normally is made of a ferrous alloy or semi-steel to provide a stronger, harder casting which will give greater wear resistance than the gray iron casting commonly used for many years. Although it is more difficult to machine than gray iron, the stronger, tougher material permits thinner casting walls, thus saving weight and improving cooling.

The lower part of the crankcase is called the oil pan. It provides a reservoir for the storage, cooling and ventilation of engine lubricating oil. It also encloses the lower part of the crankcase. The oil pan is bolted or screwed to the lower flange of the main casting and usually is made of pressed steel or aluminum.

The CYLINDER HEAD is a separate casting bolted to the top of the cylinder block and contains the combustion chamber. In this cylinder head are mounted the spark plugs and, in most instances today, the valves. To carry the flow of cooling water, the cylinder head contains passages which meet those of the cylinder block. The cylinder head usually is made of gray iron or aluminum alloy. It is cast separately from the block to make possible removal for cleaning carbon and grinding valves. To retain compression in the cylinders, a gasket (constructed of a flat piece of copper asbestos or of steel and asbestos) is placed between the cylinder head and the cylinder block sealing the joint.

All cylinder heads, whether cast iron or aluminum, should be tightened down with a special tool, called a torque wrench, to the manufacturers' specifications. Uneven tightening causes distortion of the cylinder block, which in turn prevents the valves from seating squarely, eventually warping them and resulting in loss of compression. It is also possible that the cylinder head gasket will blow out or leak.
Pistons are slightly smaller in diameter than the bore of the cylinder. The space between the piston and cylinder wall is called the "piston clearance." This clearance is necessary for two reasons: (1) the pistons reach a higher temperature than the cylinder walls, which are cooled by the water surrounding them; and (2) it is necessary to provide space for a film of lubricant between the piston and the cylinder wall. Pistons are made of aluminum alloys, cast steel, cast iron, or chrome nickel. In today's automobiles surfaces of pistons are "anodized," that is, treated with a coating of tin or zinc oxide. Aluminum alloy pistons usually are lighter than other types and are excellent conductors of heat, but they expand more and consequently require some means of compensation for this characteristic, such as vertical slots.

The top of the piston is called the head, and the part below the ring grooves is called the skirt. In some piston designs the cross section of the piston skirt is oval. As the piston expands the oval skirt tends to become round. The portion of the piston that separates the grooves is called the lands.

PISTON RINGS fit into the ring grooves and seal, with the help of oil, the compressed and expanding gases above the piston. At the same time the rings prevent the oil from entering the combustion space and causing carbon deposits on the cylinder head and the top of the piston. A third purpose of the rings is to transmit heat from the pistons to the cylinder walls.

The top two rings are called compression rings, and are designed to maintain cylinder pressure. The bottom one or two rings are called oil-regulating rings. They scoop the excess oil from the cylinder walls and return it through horizontal slots to the piston ring grooves. From there it passes through the oil drain holes inside the piston.

Practically all piston rings are of the concentric type, that is, they are uniform in size around their entire perimeter. Piston rings have joints allowing them to be expanded and slipped over the piston into their grooves, and to compensate for expansion and wear. Rings usually are made of cast iron. Those used today are commonly plated with chromium, cadmium or tin, or given a surface treatment to reduce wear and eliminate scuffing.

The PISTON PIN, or wrist pin, links the piston to the connecting rod. Usually it is hollow and made of case hardened steel. There are three commonly used methods of making the connection: (1) the pin is fastened to the piston by set screws through reinforced sections, called the piston bosses; (2) the pin is fastened to the connecting rod with a clamp screw; or (3) a floating pin is used. The latter is free in both the connecting rod and the piston, but is prevented from coming in contact with the cylinder wall by two lock rings which fit in grooves in the outer end of the piston bosses.

The CONNECTING ROD is the connection between the piston and the crankshaft. It joins the wrist pin with the crank of the crankshaft. The lighter the connecting rod and the piston, the greater the resulting power and the less the vibration, because the reciprocating weight is less. Connecting rods in American automobiles are made of steel forgings, although aluminum alloys have been used both in this country and in Europe. Rods are matched carefully in sets of uniform weight to maintain engine balance. The rod usually has an I-beam cross section. The lower part of the rod is split to permit clamping around the crankshaft. The split usually incorporates bearings lined with steel-backed copper-lead, or steel-backed cadmium-silver. The lining may be either in the form of a separate split shell, called a bearing insert, or it may be spun on the inside of the rod and cap during the manufacture of the connecting rod. Thin pieces of metal called shims, sometimes are used with spun bearings.
The CRANKSHAFT, along with the connecting rod, converts the power delivered to the piston by the burning gases from an up-and-down, reciprocating motion, to a rotary motion. In operation, it applies the principle of the simple machine known as the wheel and axle. The crankshaft is made from a steel forging or casting, and is machined and ground to provide suitable journals for the connecting rod and main bearings. The main bearings fit the main journals of the crankshaft and hold the crankshaft on its rotating axis. The number of main bearings depends on the design of the engine, and the number of cylinders. There must be at least two, one at the front of the crankshaft and one at the rear. The maximum number on a given engine cannot exceed the number of crankthrows plus one, that is, one between each crankthrow and one at each end. The more main bearings, the less possibility of vibration and distortion in a crankshaft of a given size. A flywheel is fastened to the back end of the crankshaft. It stores up energy and carries the rotating shaft over the points not receiving power impulses from the explosions. The flywheel also is a part of the clutch mechanism, fluid drive or automatic transmission. The starting motor drive connects to teeth on the outside rim of the flywheel.

To reduce engine vibration to a minimum, the crankshaft and flywheel are balanced separately, and then often are tested for balance when mounted together. Balance tests are of two kinds — "static" and "dynamic."

In testing for static balance the parts to be tested are laid on a pair of flat bars called "ways," which are exactly level. If the part tends to roll when placed on this level surface, it is out of balance. To balance a flywheel small holes are bored in the rim. To balance a crankshaft metal is ground off at the throws until the parts will not roll when placed in any position.

An engine crankshaft and flywheel in perfect static balance may not be in correct dynamic balance, because it is possible to have the weight equally distributed around the centerline (thus giving correct static balance) and still not have the weight directly opposite another weight which balances with it (so as to produce correct dynamic balance). If the shaft is not balanced dynamically, it will wobble endwise setting up serious engine vibrations.

To further reduce vibration, counterweights are located opposite the crankthrows. Also, the main bearings between the crankthrows help to eliminate vibration.

Valves control the intake of fuel into the cylinder, and the output or exhaust of hot gases resulting from the combustion process. Two valves, an intake valve and an exhaust valve, are commonly used for each cylinder. Fuel is admitted by the intake valve, and the burned gases escape through the exhaust valve. Some special engines have two intake and two exhaust valves per cylinder. Valves also seal the combustion space when closed during the beginning of the power stroke. Loss of compression will result if the space is not sealed.

Crankshaft and flywheel of a V-8 engine.
The movement of the valves is accomplished by a cam, which is a projection on the camshaft. The cams, one for each valve, are precision-ground and polished. The camshaft is driven by a chain drive or gears from the crankshaft. As the camshaft turns, the cam lifts the valves. The closing of the valves is accomplished by a spring. These valve springs must have considerable tension to assure prompt closing and prevent the valves from jumping away from the cams, especially at high engine speeds.

Exhaust valves are usually made of a special alloy of silicon and chromium, or some other alloy resistant to heat. Intake valves, being subject to less heat, generally are made from nickel-chromium alloy steel. The head of the valve is ground to an angle matching that of the valve seat in the head or block, so it makes a snug fit. Some engines have different angles for the exhaust and intake valves. Valve-seat inserts often are pressed into cylinder block or head to reduce wear, prevent leakage and to decrease frequency of valve grinding. These are of special alloy steel and are replaceable. The seat inserts usually are used only for exhaust valves.

It is highly important that valves open and close at exactly the correct moment in the engine cycle. During the suction stroke the intake valve must be open wide to admit the charge. In most automobile engines the intake valve opens slightly before the piston starts downward on the suction stroke, and closes after the piston has started upward following completion of the suction stroke.

Valve timing is controlled by the camshaft. Rotating at half the speed of the crankshaft, the camshaft allows only one valve to open on every other stroke in the four-stroke-cycle engine. The intake valve remains open to allow a full charge of fuel and an equalization of atmospheric and cylinder pressures until the piston is well along on its next stroke, the compression stroke. The piston moves upward, closing the space in the cylinder and compressing the charge. At that point the compressed gases are ready to be ignited and burned.

As the piston is forced down by the expanding gases it is necessary for the exhaust valve to open before the piston reaches the end of the power stroke. Obviously it would be wrong to keep the exhaust valve closed up to the very moment when the piston is about to move upward, because then (at the beginning of the exhaust stroke) the piston would be confronted for an instant with the force which had just driven it downward and, until the valve was open wide, there would be a considerable loss of power. On the other hand, if the exhaust valve opens too early, power is wasted because the gases are released before they have completed exerting pressure on the piston.
During the next upward stroke — the exhaust stroke — the remaining gases are forced out of the open exhaust valve, because the pressure in the cylinder exceeds that in the exhaust manifold. This causes a slight compressing of the gases ahead of the piston reaching its topmost position, thus there is a certain amount of compressed exhaust gases in the clearance space. If the exhaust valve were to be closed at this point, a large portion of those gases would be retained in the cylinder.

The best results are obtained when the exhaust valve is held open until a short time after the piston has begun to move downward on the next intake stroke. It might appear this would result in drawing the exhaust gases back into the cylinder. Two conditions, however, prevent such a drawback; (1) the gases under compression exceed the pressure in the manifold and consequently continue to flow out because of the difference in pressure; and (2) while at the top of the stroke, the piston moves but very little in relationship to the 10-15 degree movement of the crankshaft. This does not increase the combustion space. Usually it is in this region that the exhaust valve is closed after reaching top dead center (T.D.C.).

By comparing this valve data it is apparent that there are times when both valves are open simultaneously. This is called valve overlap. The pre-admission of the intake valve causes it to overlap 18 degrees with the exhaust valve before top dead center. After the T.D.C. closing of the exhaust valve a 20-degree overlap is produced between that valve and the intake valve. Therefore, in an engine with this arrangement there is a total valve overlap of 38 degrees.

As you have seen in this section, the automobile is made up of a number of parts. Those parts are precision-made from many different metals and alloys, each best suited for the purpose. The parts are carefully assembled and timed to produce a Power Unit capable of developing the horsepower and performing in accordance with the manufacturer's specifications. How well you take care of an automobile engine has a great deal to do with what happens to the horsepower as the car gets older. Experience has shown that it is possible for the horsepower after a year of driving, to remain about the same as when the car was new. Or, the horsepower can drop. This depends on the operator.

To maintain horsepower, cleanliness should be the watchword — you will want to keep the inside of the engine clean. To produce power the engine burns fuel and air, and exhausts the unburned gases. But foreign material which enters the engine stays in it and usually causes damage. If foreign material is kept to a minimum, better performance will be achieved. So you will want the engine to use clean air, clean fuel, clean hot spark, clean water and clean lubricants. In the sections which follow you will learn about those requirements in more detail.
UNIT 2, SECTION I  THE ENGINE AS A POWER UNIT

LET'S DISCUSS

1. Should premium gasoline be used in your family's automobile? How many members' families use it?

2. How does the compression ratio affect the grade of gasoline used?

3. What is the advantage of a torque converter? How many members have a torque converter in their family automobile?

4. What is the relation of accessories on an automobile to the horsepower delivered to the wheels? How many accessories does your family's automobile have?

LET'S DO

1. Using worn parts, make an exhibit of parts studied in this section. Be able to show where each failed to do its part to develop power.

2. With the help of a mechanic, take the compression on your family automobile (with parent's consent). Keep a record of the reading. Compare it with those of other members.

3. With the help of a mechanic (and parent's permission), regap the plugs. Use a wire gauge.

4. Service the battery. Use a hydrometer.

5. Clean the outside of the engine, with the help of a mechanic. (NOTE: Do NOT Use Gasoline)

6. With the help of a mechanic (and family approval), check the timing with a timing light. What did you find?
UNIT 2, SECTION II

Air is vital to the operation of the engine of a car. Indeed, the engine cannot run without air. Amounts used are enormous. Normally about 15 pounds are used for each pound of fuel burned in the engine (a pound of gasoline is not quite one and one half pints). That is called an air-fuel ratio of 15 to 1. By volume the engine uses about 9,000 times as much air as it does gasoline. Burning one gallon of gasoline requires an amount of air equal to that contained in a room 10 feet wide x 15 feet long x 8 feet high, like a good-sized bedroom.

Actually, it is only the oxygen in the air which is used in burning the fuel. During combustion in the engine the oxygen in the air combines with the fuel. Nitrogen passes through the engine unchanged. Air contains about 12 per cent oxygen and 79 per cent nitrogen.

Air enters the engine of the car through the air cleaner on the carburetor, then follows this path: carburetor, intake manifold, intake valve, combustion chamber, exhaust valve, exhaust manifold, and exhaust pipe.

The partial vacuum caused by the piston moving down on the intake stroke causes air to rush into the engine. When air is forced in with a blower the engine is called a super-charged engine.

An air cleaner is needed on an engine for two reasons:
(1) to keep the dirt in the air from entering; and (2) to act as a noise silencer.

All air contains dirt to some degree. When small particles of very hard material in the air get into the engine they cause rapid wear of the parts — intake valves, cylinders, piston rings and bearings. During 1,500 miles of driving the air taken into an average engine may contain up to 5 pounds of dirt.

The large quantities of air used by the engine travel at very high speeds (up to 290 miles per hour) and the noise would be objectionable, if it were not for the air cleaner acting as a silencer.

Three types of air cleaners are used on motor vehicles to catch dirt particles as the air passes through — oil-wetted, oil-bath, and dry types. The two former types depend on oil-coated mesh or gauze to catch the dirt particles. The dry type utilizes a cellulose material treated with resin to make it water repellant. The holes in it for passage of air are smaller than the dirt particles, so the dirt is trapped mechanically rather than by the oil.

In the oil-wetted type the trapped dirt eventually soaks up the oil and the cleaner loses its effectiveness, permitting dirt to pass through into the carburetor and on into the engine. For that reason the filter element should be cleaned periodically. This is done by removing the filter and washing it in kerosene. After it is cleaned it should be dipped in oil, drained and replaced in the air cleaner. This should be done about every 1,000 miles of driving, or more often if the driving had been under dusty conditions.

The oil-bath filter is similar to the oil-wetted type, but has a larger element. In addition, a supply of oil is under the filter element. As air rushes...
through the filter it picks up oil and carries it into the gauze. Dirt caught in the gauze is washed down into the oil reservoir by the oil.

In this type of filter the oil reservoir should be emptied periodically, cleaned and refilled with new oil. In refilling, two things are very important. First, the oil of the weight specified by the manufacturer, or in the owner's manual, should be used. Oil that is too heavy will not be carried into the gauze; oil that is too light may be carried on through the air cleaner into the engine. Second, the oil must be brought up to the level specified. If the level is too high, oil may pass into the engine. If too little is put in, it may not wet the gauze sufficiently and dirt may pass into the engine. The filter element should be washed in kerosene, or some other safe solvent (NEVER gasoline), before it is replaced in the cleaner.

The oil bath type of cleaner should be checked for dirt accumulation and serviced when necessary, particularly when dusty conditions exist.

The dry type is serviced by removing the cartridge and tapping it firmly, but gently — on a flat surface to shake out accumulated dirt. Some service stations and garages have special compressed air equipment to blow out the dirt. The dry type air cleaner should be checked often, especially when driving is done under dusty conditions. A new cartridge should be installed every 10,000 miles, or once a year, whichever occurs first.

Air leaks between the air cleaner and the engine allow dirty air to bypass the air cleaner and get into the engine. A check should be made frequently for any leaks in the gaskets between the air cleaner and the carburetor, the carburetor and the manifold, and the manifold and the engine.

When a piston travels down in the cylinder it tends to push air out of the crankcase. On the upward travel of the piston air will be drawn into the crankcase. Some method must be provided to clean the air which is drawn into the crankcase. This is usually done by means of an oil-wetted gauze in the oil filler pipe cap.

In addition to the air being drawn into and forced out of the crankcase by the piston, there are materials which must be removed from the crankcase by ventilation. Large amounts of water are formed when gasoline is burned in the combustion chamber (more than 1 gallon of water for each gallon of gasoline). That is why you see water running out of the exhaust pipe on a cold day. Because of high pressures in the cylinder during the power stroke, some exhaust gases containing water vapor are forced past piston rings into the crankcase. During cold engine operation unburned fuel also is forced down into the crankcase. A large part of the water vapor and unburned fuel can be removed by ventilation.

A crankcase ventilation tube or road tube, which extends from the top of the crankcase to below the engine, provides a means of accomplishing the ventilation. As the car moves air is sucked out through the open tube. Under normal driving conditions and engine temperatures the ventilating system removes nearly all the water vapor and harmful gases from the crankcase. During intermittent cold weather operation, however, the system does not function effectively enough to prevent accumulation of those contaminants in the crankcase. Because so much driving is of a "stop-and-go" nature with a cold engine, it is important to change oil regularly, particularly in cold weather.

Follow the manufacturer's recommendations on crankcase breather service. The air breather may have to be serviced more often under dusty conditions. Servicing the crankcase breather is similar to servicing an oil-wetted air cleaner. The breather cap is removed, washed in kerosene and allowed to drain out before the cap is replaced on the engine.

Power brakes have air filters which should be serviced according to manufacturer's instructions. If the air filter becomes clogged, the power braking unit will not operate. The brakes will still operate with pedal pressure.
UNIT 2, SECTION II  THE ENGINE NEEDS CLEAN AIR

LET'S DO
Service (or have serviced) the air cleaner on your family car and fill in the blanks below.

1. Which type of air cleaner does the car have?
   Oil-wetted type ____________________________________________
   Oil-bath type ____________________________________________
   Dry type _________________________________________________

2. If it is the oil-wetted type, remove and inspect the filter element. What was its condition? ____________________________________________

3. If it is the oil-bath type, remove and inspect the filter element. What was its condition? ____________________________________________

   Remove the oil reservoir and pour out the oil. What was found? ____________________________________________

4. If it is the dry type, remove and inspect the filter element. What was its condition? ____________________________________________

5. What grade of oil is recommended for the air cleaner?
   Summer ____________________________________________ Winter ____________________________________________

6. Service the air cleaner. List below each step of the service:
   1. ____________________________________________
   2. ____________________________________________
   3. ____________________________________________
   4. ____________________________________________
   5. ____________________________________________
   6. ____________________________________________

7. Check for air leaks between the air cleaner and the engine.
   Gasket between air cleaner and carburetor ____________________________________________
   Carburetor gaskets ____________________________________________
   Manifold gaskets ____________________________________________

8. How often is the air cleaner of your family car serviced? ____________________________________________

9. Locate the crankcase breathers on the engine. ____________________________________________
   How many did you find? ____________________________________________

10. Service the crankcase breathers. List the steps you followed.
    1. ____________________________________________
    2. ____________________________________________
    3. ____________________________________________
    4. ____________________________________________
    5. ____________________________________________

11. How often is the breather cap serviced? ____________________________________________
LET'S ANSWER

Read the questions thoroughly. Place on the line at the right the letter which represents the correct answer.

1. An automobile engine will usually use: (A) 10 lbs. of air for each 1 lb. of fuel; (B) 20 lbs. of air for each 1 lb. of fuel; (C) 15 lbs. of air for each 1 lb. of fuel.  

2. The part of the air which is used in the engine is: (A) nitrogen; (B) oxygen; (C) other gases.  

3. Dirty air entering the engine will cause: (A) rapid wear; (B) no wear; (C) some wear, but not serious.  

4. The oil-wetted type of air cleaner should be serviced: (A) more often than the oil-bath-type; (B) less often than the oil-bath type; (C) just as often as the oil-bath type.  

5. The oil-wetted air cleaner should be serviced every: (A) 100 miles; (B) 1,000 miles; (C) 10,000 miles.  

6. The oil-bath air cleaner should be serviced every: (A) 500 miles; (B) 5,000 miles; (C) 10,000 miles.  

7. The weight of the oil used in the air cleaner is: (A) not important; (B) of some importance; (C) very important.  

8. The level of the oil in the oil reservoir is: (A) not important; (B) of some importance; (C) very important.  

9. The dry air cleaner should be serviced every: (A) 500 miles; (B) 2,500 miles; (C) 5,000 miles.  

10. The purpose of the breather cap is to: (A) remove dirt from the air in the crankcase; (B) permit ventilation of crankcase with clean air; (C) remove water from the air.  

11. The breather cap should be serviced every: (A) 500 miles; (B) 2,000 miles; (C) 5,000 miles.
The FUEL SYSTEM for the automobile engine is made up of many parts. These include the storage tank, gauge, lines, pump, filter, sediment bowl, carburetor, intake and exhaust manifolds, and exhaust pipe.

Gasoline is stored in the tank at the rear of the car (with only a few exceptions like the Volkswagen), and is pumped through the fuel lines into the carburetor.

In the simplest carburetor there is a tube, called the carburetor barrel, which is about an inch in diameter. This is located alongside of the float chamber or carburetor bowl. Air passes from the air cleaner through the carburetor barrel to the engine.

One section of the carburetor barrel is smaller in diameter. This section is called the venturi, and causes the speed of the air flowing through the barrel to increase. As the speed of the air increases, the pressure decreases in the venturi and is lower than that in the carburetor bowl. As a result, fuel from the carburetor bowl flows through a nozzle into the air stream. The amount of air is regulated by a throttle valve which is controlled by the accelerator.

It is the job of the carburetor to mix air and fuel in the proper proportions for the engine under all conditions of operation. As you learned in Section II, an air-fuel ratio of 15 to 1 is about correct for normal engine operation. Actually, gasoline will burn from a ratio of about 18 to 1 down to a ratio of about 8 to 1. A fuel mixture containing more air than usual, say about a ratio of 16 to 1, is called a lean-mixture. One containing less air than usual, say about 14 to 1, is called a rich mixture.

A richer mixture is needed for easy starting, slow engine speeds, rapid power acceleration, and full power operation of the car's engine. To assure the proper air-fuel mixture for the various conditions a number of carburetor "circuits" are provided. Usually there are: float, low-speed, main, full power, accelerating or pump, and choke circuits.

The purpose of the float circuit is to maintain the proper level of fuel in the carburetor bowl. Fuel is forced into the bowl by the pump through the fuel inlet and past a hinged float. The float raises as the fuel enters the bowl, closing a small needle valve known as the float valve, and stopping the flow of fuel. The float must be properly adjusted so that the correct fuel level is maintained in the bowl. If the level is too high, the mixture will be too rich and poor gasoline mileage will result. If the level is too low the mixture will be too lean and engine power will be lost.

The low-speed circuit provides the richer mixture required for idle and low-speed operation of the engine. At low engine speeds there is not sufficient air velocity past the main fuel nozzle to supply the necessary fuel. The idle speed of the engine is controlled by a stop screw, which determines how far the throttle closes when the accelerator pedal is released.

The main-circuit provides the correct air-fuel mixture during the normal range of driving speeds. The amount of fuel which flows to the engine is controlled by the main jet, or nozzle, and the throttle valve opening.

Full power operation requires a richer fuel mixture than does average engine speed. Thus, it is necessary to add to the fuel delivered by the main circuit.
This is accomplished in several ways by the full power circuit.

The accelerating or pump circuit supplies the richer mixture required for smooth acceleration. When the accelerator is pushed down, an accelerator pump injects a stream of fuel into the air stream. A meter mechanism determines how much fuel will be injected, as well as the length of time required for the injection. The vacuum in the manifold also is utilized to control the fuel injection.

The choke circuit performs the job of providing a richer mixture for starting the engine. This is needed because gasoline does not vaporize — change from liquid to gas — rapidly at low temperatures. During starting the choke valve is closed or nearly closed. This reduces the amount of air available to the engine and results in a richer mixture. Some chokes are hand-operated from the instrument panel; most are controlled by a thermostatic spring. With an automatic choke when the engine is cold, the spring holds the choke closed. As the engine warms up the spring opens the choke valve. If the engine does not start readily and tends to flood, the spring-controlled choke valve may be opened by pressing down the accelerator pedal as far as it will go.

To burn properly in the engine, gasoline must be vaporized completely. Temperature is important in obtaining complete vaporization and this is where manifold heat control is employed. The additional heat needed when the engine is cold is provided by passing the exhaust gases, which are very hot, around a portion of the intake manifold by means of a thermostatically controlled valve. As the engine warms up, the valve closes so that the gases pass out directly through the exhaust pipe.

On some V-type engines, the exhaust from only one bank of cylinders is by-passed to the intake manifold. That exhaust then crosses over to the other exhaust manifold and leaves the engine from one tailpipe. After the engine warms up the valve changes position and the exhaust passes out through both tailpipes.

To obtain dependable engine operation, the fuel system must be maintained properly. The gas tank should be kept as full as possible at all times to prevent water from condensing and collecting, which happens frequently during warm days and cool nights. If atmospheric temperature is low enough, water in the gasoline may freeze and stop the flow of fuel to the engine. Water in the gasoline also can affect the operation of the carburetor. If water does collect, it will settle to the bottom of the tank because it is heavier than gasoline. It can be removed through the drain in the bottom of the tank. Another way to get rid of the water is to add a half-pint of alcohol to 10 gallons of gasoline when the tank is being filled.

In certain parts of the country due to sudden changes in the seasons, the liquid gasoline in the fuel line may become a vapor. The fuel pump will pump only liquid; thus when vapor reaches the fuel pump no liquid passes to the float chamber. This is called "vapor lock." The remedy is to cool the fuel line so as to condense the vapor.

As part of proper maintenance the sediment bowl, usually located at the fuel pump, should be cleaned regularly. This can be done by loosening the thumb nut and removing the bowl with a twisting motion. The filter of the sediment bowl also should be inspected and cleaned at the same time.

Many cars today are equipped with a gasoline filter, located in the line near the fuel pump. This should be serviced or replaced by a serviceman, according to the manufacturer's recommendations.

Special tools, materials and techniques are needed for proper carburetor maintenance. Such work should be done in a well-equipped shop by an experienced serviceman.

Diagrammatic sketch of the automatic choke.

One type of mechanical fuel pump and sediment bowl.
UNIT 2, SECTION III  

HOW THE FUEL SYSTEM WORKS

LET'S DO

Service (or have serviced) — with parent approval — the fuel system in the family car and fill in the blanks below. DO NOT service the carburetor yourself — this requires a trained serviceman.

1. Trace the fuel line from the tank to the fuel pump. What was the condition of the line? ____________________________

2. Under the guidance of the leader, remove the sediment bowl, clean the bowl and screen and replace. List the steps followed: (Put a new gasket on bowl.) ____________________________________________

What did you find in the bowl? ____________________________

3. Under the guidance of the leader, disconnect the fuel line from the carburetor. Is there a fuel screen at the point of attachment? ____________________________

If there is a screen, clean and replace it. Then replace the fuel line securely.

4. Locate the screw for the idle speed adjustment. How does it change engine speed? ____________________________

5. Locate the idle mixture adjustment. Is there only one? ____________________________

If more than one, how many? ____________________________

6. Locate the heat regulator on the manifold. Does it move freely? ____________________________

LET'S ANSWER

Read the questions thoroughly. Place on the line the letter which represents the correct answer.

1. The purpose of the carburetor is to provide the engine with: (A) the proper amount of air; (B) the proper amount of fuel; (C) the correct air fuel mixture. ____________________________

2. Under normal operating conditions the air-fuel ratio should be about: (A) 18 to 1; (B) 15 to 1; (C) 16 to 1. ____________________________

3. For easy starting the air-fuel ratio should be: (A) richer than normal; (B) about normal; (C) leaner than normal. ____________________________

4. The level of fuel in the carburetor bowl is controlled by: (A) the pressure of the fuel pump; (B) the amount of fuel in the tank; (C) the float. ____________________________

5. Too high a fuel level in the carburetor bowl results in a rich mixture. This may be caused by: (A) dirt under the float needle valve; (B) clogged screen in the sediment bowl; (C) partly clogged main jet. ____________________________

6. The accelerator pedal controls the opening of the: (A) throttle valve; (B) choke valve; (C) manifold heat control valve. ____________________________

7. The main or high-speed jet. (A) cannot be adjusted; (B) can be adjusted. ____________________________

8. The purpose of the manifold heat control valve is to: (A) retard the flow of exhaust gases; (B) provide additional heat to the exhaust manifold; (C) provide heat to the intake manifold for more complete vaporization of the fuel. ____________________________

9. If you see a car with two exhaust pipes but exhaust is coming from only one pipe, it indicates that (A) one exhaust pipe is connected to the engine; (B) the float valve is not working; (C) the manifold heat control valve is by-passing all the exhaust to one pipe. ____________________________
A TINY ELECTRIC SPARK is the vital item when starting the engine of a car. The electric spark has the job of igniting the air-fuel mixture in the combustion chamber of the power unit.

To produce the spark and make it perform properly, the car has an ignition system. This system includes the battery, switch, coil, distributor, wiring and spark plugs.

For each mile an eight-cylinder car is driven a spark must be produced about 12,000 times. At 60 mph, for example, 200 sparks must occur each second.

The source of electricity for the car's ignition system is the battery. Today's cars are equipped with 12-volt batteries to supply power for the increasing number of accessories, such as power steering and brakes, air-conditioning, power windows and locks and to start the modern high compression engines.

The voltage in the battery must be stepped up to this requirement. This is done by the coil which is made up of a primary and a secondary winding. The primary winding is several hundred turns of fairly heavy wire, and the secondary has 15,000 to 25,000 turns of very fine wire. The two windings are close together but are well insulated.

There are two circuits — primary and secondary — in the ignition system of a car. The primary circuit is the one in which the battery current flows; the secondary is the one in which high voltage current flows. The secondary circuit includes the spark plugs.

In the primary circuit, current flows from one of the two terminals of the battery through the ignition switch to the ignition coil. This current goes to the primary winding and to the distributor breaker points. One of the breaker points is attached to the metal of the engine, routing the current through the engine, the frame and the ground strap to the opposite terminal of the battery from which it started.

As long as the current is flowing steadily in the primary circuit no voltage is produced in the secondary winding. When that flow of current is interrupted by the opening of the breaker points, a momentarily high voltage is produced in the secondary winding.

A condenser is placed across the breaker points to eliminate the arcing of the current as the points open.

The high voltage must be sent to each spark plug in order. For each cylinder in the car there is one spark plug. Each plug has two wires, or electrodes, which are slightly separated and which extend into the combustion chamber.

Getting the high voltage to the spark plugs in the proper order is accomplished by the distributor. Current flows from the secondary winding of the coil to the rotor of the distributor.

As the distributor shaft revolves a cam opens the breaker points and the rotor sends high voltage to each of the spark plugs in proper order. This high voltage current passes through the center electrode and as it jumps the gap to the outer electrode it ignites the air-fuel mixture. The current then passes through the metal of the engine and back to the coil, thus completing the circuit.

All of the air-fuel mixture does not burn instantly. The burning starts at the spark plug and spreads throughout the combustion chamber. About 1/350ths of a second is required for all of the mixture to burn. This is important in the timing of the

![Schematic wiring diagram of the ignition system.](image)

![Distributor for an 8-cylinder engine showing principal parts.](image)
spark — that is, the time the spark occurs in relationship to the position of the piston on the compression stroke. To obtain full power from the fuel, the burning must take place before the piston has traveled 10 to 20 degrees of crankshaft travel past top dead center (T.D.C.) on the power stroke.

The time the spark occurs also must be changed to meet the speed and load requirements of the engine. At high speeds the spark must occur sooner (advance the spark) than it does at low speeds (retard the spark). On most cars a centrifugal advance (to meet speed requirements) is combined with a vacuum advance (to meet load requirements) to provide correct ignition timing under all conditions.

Battery — It is extremely important to maintain the water at the required level in the battery. If the water remains below the top of the battery plates for any length of time, the capacity of the battery is reduced. Distilled or rain water should be used in refilling the battery.

The outside of the battery should be kept clean by washing it with a solution of baking soda and water, being careful that not any gets in the small vent holes of the filler caps. After it is cleaned, the battery should be rinsed with clean water. A light coating of grease or petroleum on the battery terminals will prevent corrosion.

Distributor — The breaker points should be inspected every 3,000 to 4,000 miles for burning and pitting and for proper amount of opening (gap). If the points are burned, they and the condenser should be replaced. Lubrication of the distributor should follow the car manufacturer's instructions.

The distributor cap should be kept clean. Dirt on the cap tends to collect moisture on damp days. This may short-circuit the high voltage to the spark plugs.

Wiring — The ignition wires should be cleaned frequently. Accumulated oil and grease tend to destroy the insulation. When this happens dirt and moisture can short-circuit the high voltage.

Spark Plugs — Spark plugs should be checked every 3,000 to 4,000 miles. Before plugs are removed the surrounding area, or wells, should be cleaned to make certain that no dirt will drop into the engine when the plugs are taken out. Plugs must be removed with the proper spark plug wrench. If the wrong wrench is used, the porcelain may break. An abrasive type cleaner should be used. If the points are badly burned, the plugs should be replaced. A wire-type gauge should be used to set the points to the correct gap. In setting plugs the electrode attached to the outer rim of the plug should be bent; never the center electrode. After cleaning and re-gapping, the plugs can be tested under pressure in a spark plug tester to see if the spark is strong. If gaskets are required when plugs are reinstated, new ones should be used. Plugs should be turned in finger-tight, then tightened another one-half turn with a spark plug wrench.

Keeping the porcelain of the spark plugs clean will prevent moisture from collecting on them in damp weather. Cleanliness is one of the most important parts of ignition system maintenance.
UNIT 2, SECTION IV  IGNITING THE AIR-FUEL MIXTURE

LET'S DO

1. Check each cell of the battery with a hydrometer. (Your leader will discuss the use of a battery hydrometer.)
   Record the reading for each cell:

2. Did the battery require service? 
   How much water did you add? 

3. What is the voltage of the battery?

4. If the outside of the battery is dirty, clean it, then tell what you did.

5. What is the condition of the battery terminals?
   What did you do to correct the situation?

6. What is the recommended breaker point gap for your car?

7. With the guidance of the leader, remove the distributor cap and check the breaker points for burning and pitting. What did you find?
   What was the breaker point gap?

8. Clean the distributor cap and inspect terminals for corrosion.

9. Check and describe the condition of the ignition wiring. Wipe all dirt from the wiring with a clean rag.
   What repair was necessary?

10. What is the recommended spark plug gap for your family car?

11. Clean the dirt from around the spark plugs and remove them with a spark plug wrench. What was the condition of the plugs?
   If needed, have them cleaned and checked. What was the spark plug gap?
   Adjust the points to the recommended spacing. Replace spark plugs, following correct procedure.
LET'S ANSWER

Please mark (T) True or (F) False.

1. The purpose of the ignition system is to ignite the air-fuel mixture at the proper time. ..............................................

2. Once the air-fuel mixture is ignited it burns instantly. ........................................................................................................

3. Ignition always occurs at T.D.C. (top-dead-center) at the start of the compression stroke. ..............................................

4. Ignition usually occurs before the piston reaches T.D.C. (top-dead-center) on the compression stroke. ......................

5. The battery voltage on all cars is either 6 or 12 volts. ........................................................................................................

6. The two circuits of the ignition system are the primary circuit and the low voltage circuit. ..............................................

7. The voltage produced at the secondary of the ignition coil is from 15,000 to 25,000 volts. ..............................................

8. High voltage is distributed to each spark plug by the rotor, distributor cap and spark plug wiring. ..................

9. Spark plug gap is of little importance. .................................................................................................................................

10. The purpose of the condenser is to provide an additional source of high voltage for the spark plugs. .................................
"What do you want to do when you grow up?" Remember your quick reply to that question at an early age? Perhaps it was fire marshal, or maybe a county sheriff. Whatever your career choice then, it was likely to be something new the following day, and different from what it is today.

You've matured a good deal since then and the same question isn't answered in the same way. It's a real decision now; the idea of your selecting a career has taken on added significance.

To face it today you've probably asked yourself questions about your education. For instance, which subjects do I prefer? Which ones do I dislike? In which school activities do I participate? In which out-of-school activities? Answers to these questions and others like them, help to pin-point your capabilities.

Equally helpful are self-inquiries about likes and dislikes of work. Do I enjoy working closely with others? Which kinds of work do I like best? For which types of work do I think I'm best suited? Your answers will establish the starting line from which to look further into career opportunities which most interest you.

Choosing your career can be something of an adventure. There is a galaxy of occupations to consider; a lot of thinking and reading to do. Presented in this section are some of the career opportunities available in highway safety. Mainly they are in education, engineering and enforcement. If you should choose a career in highway safety, rest assured that your time and energy can be devoted to no better cause than saving human lives.

Consider this: By 1989, when the Federal Interstate Highway program has been completed, some 42,500 miles of multi-lane highway will have been constructed. It has been estimated that in the coming years, several hundred thousand added individuals will be needed to complete this vast project—individuals just like you.

Highway safety work isn't new, nor are the occupations being created by the Interstate system. Yet new opportunities will continue to develop. For when that gigantic network of highways becomes a full reality, our population will have passed the 300 million mark; car and truck registration will have zoomed upward by millions. This future expansion will accelerate the demand for varied occupations in highway construction and safety. Your interests may lie in one of them.

Education
Since America was launched into the motor vehicle age driver education has become more and more important among the occupations in highway safety. Confirming this, well over half of all the public high schools in the country are offering some kind of program to train students in driving fundamentals.

At this writing, 33 states had passed laws to provide funds to school districts in support of driver training. The remaining states are expected to pass similar laws.

If you're interested in teaching driver education, you'll want to know some of the requirements which all candidates for a teaching career should possess. First you need to be mentally fit and in good physical shape. This is vital because of the very active life you will lead as a teacher. Your honesty and integrity in dealing with others gets top priority too. That you acquire and keep the respect of students and fellow teachers, and that you respect them equally is another requisite. Still another is the skill to motivate students to learn more about themselves and the world in which they live.

Highway engineers checking accuracy of completed work against blueprints. Below, written, visual and driving tests are supervised by Motor-Vehicle Inspectors.

Driver Education is taught in many of our Schools.

Excellent opportunities exist in the field of law enforcement.
Driver education teachers are responsible for classroom instruction and practice driving. Mathematics and science are stressed in class, with particular reference to the laws of science that govern moving objects. Taught also are motor vehicle laws and ordinances and good safety citizenship.

In practical on-the-road instruction of student drivers, the teacher must be capable of impressing the importance of proper driving habits. Part of this is accomplished through his good example behind the wheel. In addition to illustrating the fundamentals of car operation the teacher must have the ability to show students how their classroom training can be applied in everyday driving.

Looking ahead, the employment picture seems bright indeed for those considering a career in driving education. Authorities predict that this new branch of education will need an extra 7,000 teachers in the next few years.

Engineering
The nation’s streets, roads and highways are built to safely and efficiently move all types of motor vehicles from one place to another. To do so, tremendous numbers of workers with a variety of talents are needed. Among them, possessed of a high degree of talent, are the highway engineer and the traffic engineer.

The jobs of the highway engineer are to plan, locate, design, construct and maintain roads. To begin his career he usually must work for a short time in each of these jobs. The highway engineer also must have a basic grounding in physical laws and know how to apply them. Durability and safety of the road are two of his biggest responsibilities.

The traffic engineer, working closely with the highway engineer, is concerned primarily with the operations of traffic. These include: collecting important traffic data and analyzing accident causing; supervising the installations of warning and regulatory signs; and planning the designation of centerlines, no-passing zones and roadside exits. The goal of the traffic engineer is to attain the smoothest and safest possible flow of traffic.

To prepare for a career in either highway or traffic engineering, planning must start early in high school. Courses there should be in algebra, geometry, trigonometry, physics and chemistry, complementing a solid academic curriculum. As part of college training each engineer studies basic engineering courses during his first two years. In junior and senior years emphasis is on civil engineering along with specialized courses.

Assisting both the highway and the traffic engineer are technical specialists. Although this occupation does not require a college education, a good high school foundation in mathematics and science is required, with additional training in a particular engineering skill. Engineering technicians do work in surveying, drafting, construction, materials testing and electronics. Full or part time instruction in these skills is available at a variety of vocational schools throughout the country.

The outlook for entry in any of the three occupations is extremely good. It has been estimated that should the current crop of engineering graduates entering highways work double tomorrow, ten years or more would be needed to fill positions in government and industry.

The future for engineering technicians looks even better. Within a few years it is expected that three to four technicians will be needed for each employed engineer.

Enforcement
Whether pedestrian or driver, you are familiar with the policemen who see to it that traffic moves smoothly and without hazard. Among other things the traffic officer is responsible for enforcing the legal regulations which govern each motorist and pedestrian in the community. From chasing speeding vehicles to routinely issuing parking tickets — his job varies by the minute.

For the most part the traffic officer’s jobs are in traffic enforcement, parking and traffic control, accident investigation and education.

Traffic officers are trained to detect traffic violators and effectively deal with them. They reckon with drunken drivers, reckless speeders, and thoughtlessjaywalkers, to name a few. They help and advise law-abiding citizens and supply traffic information whenever necessary.

Investigating motor vehicle accidents makes up a large share of the traffic officer’s work. As a trainee in police school he learns how to gather facts at the scene of an accident, as well as how to record technical data for use in court trials.

To qualify for work as a traffic officer you must be at least 21 years old. In most states and counties it is necessary to be a high school graduate. Moreover there are certain physical requirements which must be met, written and oral examinations to be taken. The applicant must be free of any criminal record and possess a character of high standing.

The prospects for employment as a traffic officer are excellent. In the past, some police forces required that an applicant reside in an area for a specific number of years to qualify for employment. Today in many places this requirement has been dropped and prospective officers are being recruited on a nationwide scale.

There you have it — the abbreviated descriptions of just a few of the many careers awaiting you in education, engineering and law enforcement. There are others, many others, which deserve your consideration. In education for example, neither college level teaching in driver education nor school transportation supervision has been mentioned. The numerous occupations in the general area of motor vehicle transportation — automobile, petroleum, asphalt, and rubber industries — have not been described.

But now it’s your turn to do a little spade-work. Dig in and look for the facts on each occupation in highway safety which interests you. Your research will be well rewarded.
UNIT 2, SECTION V  CAREER OPPORTUNITIES

LET'S DO

1. Choose an occupation in highway safety which is interesting to you, and explore its possibilities thoroughly. Use the outline below and ask your leader about other sources of information.

   I. Nature of the Occupation
      A. Specific tasks to be performed
      B. Tools, machines and materials used
      C. Number of personnel employed, employment stability
      D. Conditions of employment → hours, benefits, etc.
      E. Starting salary; opportunities for advancement
      F. Related occupations.

   II. Requirements
      A. Necessary education
      B. Experience required, if any
      C. Age limits; Preference of sexes
      D. Special skills needed
      E. Physical, mental, social, and personal requirements, other than those obviously necessary for success in all types of work.

In addition to using the outline to gather information, find out how to look for employment in this occupation. Some of the ways are through newspaper want-ads, special employment agencies, by serving an apprenticeship, or by license or certification.

2. Conduct a "Career Opportunities" club meeting. Invite residents of the community whose occupations are in varied phases of highway safety. Ask them to describe their jobs and define their responsibilities.

   Following is a partial listing of those to consider:
   A. Auto mechanic, service station operator
   B. Auto sales dealer
   C. Driver education teacher
   D. County, highway, traffic engineers
   E. Judge or magistrate who hears traffic cases
   F. Local sheriff, state patrol officer
   G. Safety education supervisor of the school district
   H. Manager of local or state safety council.

Don't hesitate to ask questions about the occupations. Get as much information as you can on the one which most interests you.

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UNIT 2, SECTION VI

All the Activities of this section may be completed before taking up another section, or may be carried out along with other sections of the unit. In either case a good opportunity is presented to have some fun, learn more about cars, and become acquainted with people in your community who can help make this section a success.

You will note that every activity may not appear to be complete; all of them are not, but this is done on purpose. Many local junior chamber of commerce groups for some years have been helping young men and women improve their attitudes toward driving. If your community has such a group, ask them for assistance with this.

1. Safety Lane Check
The efficient driver maintains a constant check on his car to be certain that its many safety features are in good working order.

What are some of the safety features which can be examined readily? Some of the more obvious are wheels, tires, lights, brakes, windshield wipers, horn, glass.

With the help of a mechanic, establish a safety lane to check the safety features. Your state may require a motor vehicle inspection. If so, become familiar with the inspection procedures and requirements.

2. Braking Demonstration
Contrary to the old saying, most cars will not "stop on a dime." A controlled braking demonstration will show the distances required to stop a car at low speeds. Local enforcement authorities, or your state highway patrol, may have the equipment necessary for this demonstration. Your driver education teacher can help you understand the mathematics of stopping distances.

![Graph showing braking distances](image)

Stopping distances shown are the ranges in which you may expect a car to stop. Influencing factors are driver mental and physical reaction time, type and condition of pavement, kind of tires and tread condition, design and condition of car, type and condition of brakes and wind direction and velocity.
3. Participation in Local Safety Activities

Many automobile safety activities are conducted in your community by civic groups and clubs, schools, home demonstration councils, and women’s organizations. Your driver education teacher is the person in your community most likely to know when these programs are conducted.

As a project group in 4-H Club you have an important story — your experience with the 4-H Automotive Care and Safety Project — to all members of your area. Relating this story may provide a way in which you can participate with other groups.

In one 12-month period recently more than 46,000 lives were lost on the streets and highways of America. No community program is more worthy than the efforts of its citizens to reduce this toll.

4. Trouble Shooting

What is wrong when a car fails to start or is not operating smoothly and efficiently? It may be any number of things, but chances are the difficulty is minor.

When the engine will not start, for example, the trouble may be that the driver simply forgot to turn on the ignition switch; or the gas tank may be empty. If the engine operates irregularly or stalls, water may have been carried into the carburetor from a dirty sediment bowl; or the idling system of the carburetor may be set too lean, or it may be blocked.

Trouble shooting is an activity in which a series of simple situations can be set up which when corrected will make the car operate properly. Some common troubles are:

1. Engine will not start, or operates irregularly.
2. Engine lacks power.
3. Engine overheats.
4. Engine smokes excessively.
5. Starter will not turn over engine.
6. Brakes are “mushy,” need to be pumped or do not stop car properly.
7. Oil pressure gauge reads low or no pressure.
8. Steering wheel vibrates at certain speeds.
10. Engine suddenly stops on a hot day.

In trouble shooting you will work under the guidance of your leader, or with the help of a mechanic.

DO YOU KNOW YOUR SIGNS?

REGULATORY
Red & White Group

STOP
WRONG WAY

WARNING
Yellow & Black Group

SERVICE-GUIDE-Others
Various colors

ROAD CONSTRUCTION AHEAD

CONSTRUCTION AHEAD

NO PASSING ZONE

DO NOT PASS
UNIT 2, SECTION VII

Gases in the Combustion chamber of the engine of a car may reach temperatures as high as 4,000 degrees Fahrenheit. For that reason automobile engines are provided with cooling systems.

The cooling system is made up of the water jacket, which holds water around the cylinders and cylinder head, the circulating pump, radiator, fan, hose, thermostat, temperature indicator, and heater.

The heat in the engine is the result of burning of the air-fuel mixture. It serves to expand the gases and push the pistons down. Part of the heat is removed from the engine through the exhaust system. The remainder is conducted through the cylinder walls into the water in the water jacket. The water pump circulates the water through the radiator. There the heat in the water is transferred to the cooler air drawn through the radiator by the fan.

The thermostat controls the flow of water from the engine to the top of the radiator. As long as the engine is below its correct operating temperature the thermostat valve remains closed and the water does not circulate through the radiator. When the engine temperature rises to its proper value, the thermostat opens the valve and allows the water to circulate. Some engines have by-pass type thermostats which allow the water to circulate only through the engine block at temperatures below the operating range. When the engine temperature rises the thermostat allows the water to circulate through the radiator.

A cooling system must provide these four essentials:
1. Absorption — takes up heat from the engine.
2. Circulation — carries the heat to the radiator.
3. Radiation — throws off heat to the passing air.
4. Temperature Control — holds the temperature at the correct operating level.

Cooling system troubles show up as either overheating or overcooling. Overheating may be caused by the coolant leaking from the cooling system. If this happens, the radiator, hoses, the heater and its hoses should be checked for leaks. A leak may also occur at the cylinder head gasket. A plugged radiator may cause the pump to force the water out the overflow pipe.

Proper cooling requires a rapid transfer of heat from the engine to the water in the jacket. Use of hard water in an engine may result in a mineral coating in the water jacket, which acts as an insulator and prevents rapid heat transfer from the engine to the water. Rust and scale may collect in the bottom of the water jacket, causing poor heat transfer.

Overheating may also be caused by poor circulation of water. The inside of the entire cooling system must be clean so that the water can flow freely. If the fan belt is slipping, the pump may not pump as much water as it should. Sometimes radiator hoses collapse and flatten out, restricting the flow of water. Anything which prevents rapid transfer of heat from the water in the radiator to the passing air may cause overheating. Dirt either on the inside or outside of the radiator will prevent proper cooling. A slipping or broken fan belt may reduce the amount of air which should flow through the radiator. As a result the engine may overheat.

Overcooling usually is caused by failure of the thermostat. Bellows type thermostats are constructed so that if the bellows leaks, the thermostat opens. When this happens the thermostat no longer controls the engine operating temperature. Many people remove the thermostat during the summer, under the mistaken belief that the colder an engine runs the better it is.

### 60 HOUR GASOLINE ENGINE TEST

**OPERATING TEMPERATURE:**

- 40°F
- 100°F
- 140°F
- 160°F
- 180°F

**CYLINDER WEAR:**

- .008 in.
- .002 in.
- .001 in. (MAGNIFIED)
- .005 in.
- .003 in.

**FUEL CONSUMPTION:**

- 3.8 gal. per hr.
- 3.5 gal. per hr.
- 3.2 gal. per hr.
- 2.9 gal. per hr.
- 2.5 gal. per hr.

**POWER:**

- 26 H.P.
- 27.2 H.P.
- 28.5 H.P.
- 29 H.P.
- 29.5 H.P.

Illustration of test showing that as engine operating temperatures increase up to 180°F, cylinder wear decreases, fuel consumption decreases and power increases.

Thermostat of the Bellows Type. This remains closed until cooling water heats enough to expand the bellows, opening the valve at the top.
An engine operating at 160° F. to 180° F. will wear less, have more power, and burn less fuel than a similar engine operating at temperatures below 160° F. If the engine is overcooling, the thermostat should be checked by removing and placing it in a pan of water. As the water is being heated observe the temperature (on a thermometer placed in the water) at which the thermostat opens. It should open within 10 degrees of the temperature which is stamped on the thermostat.

It is necessary to use something other than water in the cooling system at freezing and below freezing temperatures. Water freezes at 32° F. and can cause a lot of damage if allowed to freeze in the cooling system. The purpose of the antifreeze is to lower the freezing point of the water.

Of the three types of antifreeze in use, two are more common today. The first is generally a form of alcohol which has a relatively low boiling point compared to that of water (at 212° F.). The second type is one called "permanent" type antifreeze, consisting principally of ethylene glycol. It has a boiling point higher than that of water. The third type is one guaranteed for the life of the car, but it is subject to loss or removal either through leaks in the cooling system or the breaking down of the rust inhibitor it contains. This is indicated by a change in color of the antifreeze. Alcohol antifreeze usually requires a thermostat which opens below 160° F. A high temperature thermostat may be used with permanent type antifreeze. Antifreeze should be drained from the cooling system when all danger of freezing is past. An antifreeze solution will not carry heat away from the engine as rapidly as water, and the engine may tend to overheat or knock during hot weather if the antifreeze is not removed. The rust inhibitors placed in the antifreeze to prevent rust and corrosion are used up by the time winter ends. If the antifreeze is not removed, rust and corrosion may take place in the cooling system.

Permanent type antifreeze has the ability to creep through an extremely small opening. If it leaks into the engine, deposits may form which can damage the engine seriously.

When water is under pressure its boiling point becomes higher than 212° F. The same thing would be true of antifreeze solutions. Pressure cooling means that a low pressure, usually 4 to 15 pounds, is maintained in the cooling system. This makes possible a higher engine operating temperature without boiling away the coolant. The pressure is maintained by a spring-loaded valve on the radiator cap. The valve seals off the overflow line from the radiator until the pressure in the cooling system reaches 4 to 15 pounds.

Maintenance of the cooling system consists of keeping the cooling system clean both inside and out, repairing leaks and checking to be certain the engine operating temperatures are maintained at the proper level.

The inside of the cooling system can be kept clean by: (1) using clean soft water when filling; (2) using rust inhibitor in the water; (3) flushing the cooling system with clean water; and (4) using a recommended cooling system flushing compound in the spring when the antifreeze is drained out. radiator hoses should be checked for condition. If the hoses are cracked, very soft, or otherwise in poor condition, they should be replaced.

Clean the exterior of the radiator by spraying with a garden hose from the back (under the hood, inside) to the front. Check the radiator, all hoses and the cylinder heads for leaks.

If hard water must be used in the cooling system, save the water drained from the engine. By using this water when refilling, you do not add minerals to the cooling system.

Cold water should never be put in a hot engine, nor hot water in a cold engine. A great difference in temperature between the coolant and the engine might cause breakage of the cylinder head and block.

After the engine has been run at high speeds, or has had to carry heavy loads, allow the engine to run at a fast idle for at least a minute before shutting it off. This permits proper cooling of the valves. If the engine were shut off suddenly, the valves might warp causing leaking valves and short valve life.
UNIT 2, SECTION VII  HOW ENGINE TEMPERATURE IS CONTROLLED

LET'S DO

Let's check the cooling system. Perform the work (with parents' permission) on the family car and fill in the blank spaces below.

1. Check the system for leaks: (1) the radiator, (2) all hoses and hose connections, (3) cylinder head gasket (outside only). Were there any leaks?  
   Where?  
   Did you tighten hose clamps and replace those found in poor condition?  

2. Is there dirt on the outside of the radiator?  
   If so, clean the outside of the radiator with compressed air or garden hose.

3. What is the engine operating temperature after the engine has run 15 minutes?  
   (cold, normal, hot)  

4. If the engine doesn't warm up, with the help of the leader remove and check the thermostat. What did you find?  

5. After running the engine for a few minutes, drain sample of coolant from the radiator. What was the condition of the coolant?  
   (rusty, clean, etc.)  

6. If the coolant was dirty, did you use a commercial preparation to clean the inside of the cooling system?  

7. Fill the cooling system with clean, soft water. Where did you get the water?  
   Did you add rust and corrosion inhibitor to the cooling system?  

8. Have you checked the overflow pipe on the radiator to be sure it is open?  

9. Inspect the fan belt. Is it in good condition?  
   Was the belt adjusted to the proper tension?  

10. Report other experiences below.
LET'S ANSWER

After reading each statement carefully, insert on the line at the right the letter representing the phrase which correctly completes the sentences.

1. The purpose of the cooling system is to: (A) keep the engine as cool as possible; (B) keep engine temperature up without damaging engine parts.................................................................

2. The engine operating temperature should be: (A) 160° to 180° F.; (B) 120° to 140° F..............

3. An engine operating at 120° to 140° F. will: (A) use more fuel and wear less rapidly; (B) have more power; (C) burn more fuel, wear faster, and have less power than an engine operating at 160° to 180° F.................................................................

4. The purpose of the thermostat is to: (A) control the amount of heat in the coolant; (B) control engine operating temperature.................................................................

5. The thermostat controls the operating temperature by: (A) regulating the amount of coolant in the radiator; (B) varying the capacity of the water pump; (C) varying the amount of air passing through the radiator.................................................................

6. Soft water should be used in the cooling system because: (A) it carries more heat; (B) it has no minerals to form deposits in the cooling system.................................................................

7. Anti-freeze should not be left in the cooling system in the summer because: (A) it evaporates; (B) it carries more heat than water; (C) it carries less heat than water and the rust inhibitor is used up.................................................................

8. The purpose of a pressure cooling system is to: (A) increase operating temperatures without loss of coolant; (B) decrease engine temperatures.................................................................

9. Overheating of the engine may be caused by: (A) no thermostat; (B) loss of coolant; (C) fan belt too tight.................................................................
PROPER LUBRICATION is the most important single item affecting the operation of a car. Lack of lubricant will quickly ruin an engine, transmission or axle. Failure to use the right lubricant and to do the few simple things needed to keep the lubricant clean and in good condition can cause hard starting, power loss, wear and other costly troubles. Lubricants are a very small item — 3 to 4 per cent — in the cost of running a car, but correct lubrication is insurance against expensive repairs and loss of the car's use.

What Lubricants Have To Do
The primary job of all lubricants is to reduce friction and wear. It takes a lot of force to slide dry surfaces over each other, especially under heavy pressure and at high speeds. This resistance to motion is called friction. Friction generates heat, causes wear, and reduces power.

A lubricant keeps the surfaces separated and replaces solid, dry friction with fluid friction — which, by comparison, is very small. By separating moving surfaces the lubricant prevents wear; it also carries away heat caused by fluid friction and generated by the burning fuel. Piston heat is transmitted to the cylinder and water jacket through the oil film on the walls and around the rings, also to the crankcase supply by the oil that is thrown against the insides of the pistons.

Around the piston rings, oil acts as a seal to prevent gas leakage and pressure loss during both compression and power strokes. For chassis parts, the lubricant keeps out dirt and water as well as reduces friction.

The engine crankcase should be drained regularly. How often depends on how fast the oil gets dirty. Fresh clean oil never hurt an engine — dirty oil can do a lot of damage.

Engine Lubrication Requirements
In the engine of a car the oil should do these things:

1. Permit easy cranking in cold weather — fluid friction must be low at the starting temperature.

2. Flow promptly to the oil pump and through the oil screen — the oil must not congeal when chilled to the lowest temperature at which one expects to use the car.

3. Protect the working surfaces against two kinds of wear, frictional and corrosive — oil can protect against friction and corrosion, but not against a third kind of wear, the abrasive wear which lubricants can't stop. It is caused by road dust, metal particles and other kinds of abrasive dirt getting into the oil.

4. Keep the inside of the engine clean — soot and other products of fuel combustion, including water, mix with the oil film on the cylinder walls and are scraped down into the crankcase by the rings, forming deposits called sludge or lacquer.

5. Prevent fuel knock and pre-ignition — in high compression engines especially, carbon deposits inside the cylinders and on piston heads make the fuel mixture burn irregularly and violently, causing a pinging or knocking noise and power loss. Deposits often ignite the mixture before the spark does. This causes loss of power, rough running, noisy operation and severe overloading of pistons, rings and bearings. While mechanical and operating conditions also can cause these troubles, some kinds of oil reduce or stop them by changing the character and amount of the carbon deposits.
6. Be economical to use — oil consumption mostly depends on how badly worn are the piston rings, cylinders and bearings; on leaks around the engine; how hot it gets, and how fast one drives.

Good oils by holding down wear and keeping rings clean and free, help engines give high oil mileage. By reducing friction oils can improve gas mileage too.

How Oil Does Its Job

Many different properties of oil play a part in making an engine run right and last a long time without repairs.

Viscosity is the yardstick for measuring the fluid friction or resistance to motion of oil. This often is called the body, thickness or weight of oil; actually it has nothing to do with how much oil weighs. Because it is very difficult to measure directly the resistance to motion of a small, thin film of oil, the job is done by timing in seconds how fast a given amount of oil will flow through a small tube. The thicker the oil is, the slower it flows — the more it resists being moved — hence, the higher its viscosity.

Viscosity is the property which controls the No. 1 lubrication job — letting an engine get started, especially in cold weather. If viscosity is too high, the starter can’t turn the engine over fast enough to draw in a fuel charge and get going.

While oils can be made of any desired viscosity at any temperature, they all are alike in one way: they thin out when heated and get thicker when chilled. For this reason viscosities commonly are measured at specified temperatures which are important in service and in oil manufacture.

The numerical viscosity range of oils was developed by the Society of Automotive Engineers (SAE) and is used by the manufacturers of automotive lubricants. The oil must flow at all temperatures of engine operation, must provide a protective film between rubbing metal surfaces at all times, and must not be too thin at high temperatures nor too thick at low temperatures.

Grades of crankcase oil are numbered on the SAE viscosity range from 5W, the highest or “thinnest” through 10W-20-30-40 or 50. The SAE viscosity range of manual transmission and differential lubricants are numbered SAE 75, 80, 90, 140, and 250. Most differentials require a lubricant manufactured for hypoid gears. Automatic or semi-automatic transmissions, fluid couplings and torque converters require special lubricants recommended by the manufacturer. Generally Type A Transmission fluid meets the requirement, but the owner’s manual should be consulted in making this determination and for servicing.

Multi-purpose type chassis lubricants will generally meet the requirements for front end suspension, steering linkage and other general lubrication points. Rubber lubricant is used on spring shackle rubber bushings, rubber mounts on shock absorbers and other places.

Factory packed and lubricated bearings with a specified mileage life should be repacked or relubricated by the dealer, as specified in the owner’s manual. Automobiles requiring lubrication of the front end suspension and steering linkage at 30,000 mile intervals should be serviced by a certified dealer.

A complete and more technical discussion on selection of lubricants will be covered in Unit III, Section IV.
UNIT 2, SECTION VIII  GENERAL LUBRICATION

LET'S DO

Find the information necessary to fill out the blanks. Perform the operations listed.
1. What is the oil capacity of the engine in your family car? _________________________ Quarts
2. What viscosity of oil is recommended? Summer __________________ Winter ______________
3. What is the recommended transmission lubricant? ________________________________
4. What is the capacity of the transmission? ________________________________
5. What is the capacity of the rear axle? ________________________________
6. Remarks: ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

LET'S ANSWER

1. What is the primary job of all lubricants? _______________________________________

2. List the five jobs oil must perform in the engine.
   a. ________________________________________________________________
   b. ________________________________________________________________
   c. ________________________________________________________________
   d. ________________________________________________________________
   e. ________________________________________________________________

3. What is the viscosity range of crankcase oils? ________________________________

4. Viscosity refers to:
   (A) the quality of the oil __________________________________________
   (B) how freely the oil flows ________________________________________

5. What type of lubricant should be used on the chassis:
   (A) heat resistant _________________________________________________
   (B) water repellant _______________________________________________

6. SAE means:
   (A) Same All Engines _____________________________________________
   (B) Standard Automotive Effect _____________________________________
   (C) Society of Automotive Engineers ________________________________

7. How do you lubricate an automobile that travels 30,000 miles between lubrications? ________________________________

8. Remarks: ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
Over the years since the first motor vehicle was invented, many developments have taken place which enable us to enjoy comfortable highway travel today. One of these is the construction of our modern system of highways; another is the creation of the low pressure pneumatic tire.

Before 1923, almost all motor vehicles had either solid rubber tires or small tires inflated to high pressure. Imagine the discomfort of that kind of riding! If you can’t envision that, try to remember your physical condition after your first horseback ride. Or, get in your little brother’s wagon and coast down an unpaved hill. Of course, many engineering advances — both on the road and in the vehicle — are responsible for much of today’s comfort. However, the ride still would be bumpy without low pressure tires to absorb the shocks.

Tires are important for pleasurable driving, but they are just as important, and perhaps more so, from the viewpoint of safety and economy. The purpose of this section is to help you learn how to select tires and how to care for them, so you can add to the safety and economy of your motor transportation when you become a driver.

What are the kinds or grades of tires? Generally, there are three; premium, first-line, and second-line. Most tire manufacturers produce all these standard grades.

The premium tire is the highest grade. Frequently it has special features such as all-nylon cord, or a puncture-proof sealant. This grade of tire usually has an original tread life expectancy of 30,000 miles or even more, under normal conditions of driving and care.

Next in quality is the first-line tire. This grade has about the same life expectancy of the premium grade tire, but without the former’s advantage of resistance to punctures and fabric injuries.

Second-line tires sell for less than first-line and are lighter by a pound or more in rubber and weight of cords in various plies. This grade gives somewhat less mileage than the higher priced tires.

Most tire manufacturers warrant that a tire will be free from defects in workmanship and materials for its normal life. If defects appear, the tire dealer will make an adjustment based on the amount of tread wear which has occurred, with due attention to any evidence of misuse or abuse. Some manufacturers, in addition to the warranty, guarantee their tires against injuries resulting from road hazards. Such a guarantee, of course, does not apply if you drive on a flat tire.

All recently manufactured American cars are equipped with tubeless tires. A small percentage of tire production is devoted to tires requiring tubes.

A good rule of thumb in driving is always to carry a spare tire. One cannot foretell when a blowout or puncture will occur on the highway. Along with the spare, essential tools and equipment should be carried, such as a jack, lug wrench, tire tool (often a lug wrench is combined with the tire tool), tire repair kit, and a tire pump. The last two items seldom may be used, but in cross-country driving where service stations may be miles apart, they can become quite important. Most cars are equipped with a jack, usually of the bumper type, and a tire tool. In purchasing a used car one will want to make certain these essential tools are included and in good working order.

When a puncture or blowout occurs on the highway, here are some steps which will be of help:

1. Pull the car completely off the highway and turn off the engine before getting out to determine the damage.
2. Set hand brake, place car in gear and place a block under one of the inflated tires to give additional protection against rolling.

3. Remove spare tire from carrier and place near deflated tire.

4. Remove wheel cover and loosen lugs with tire tool.

5. Place jack on stand or plate and raise car to a point where deflated tire is off the ground.

6. Remove wheel with punctured tire and place spare wheel on hub. Tighten lugs. Replace wheel cover.

7. Lower car with jack.

8. Replace spare in carrier and tools in proper place.

9. Remove block.

10. Have punctured tire repaired at next service station.

These steps should be taken in mounting a tire and tube on a rim:

1. Inflate tube until barely rounded out and insert in tire. Place tire on rim, guiding valve through valve hole.

2. Push bottom bead down into well at valve and force remaining portion of bead over rim flange. A 16" tire tool will be needed to pry last portion of bead over flange.

3. Push top bead (at point away from valve) into well and insert tool between top bead and rim flange, at point directly opposite, prying bead over rim flange. Take small bites with tool and work around rim until bead is in place.

4. Inflate until beads are seated; deflate; reinflate to recommended pressure.

Tubeless tires usually are mounted with special equipment, and a dealer should be consulted when there is concern regarding a tubeless tire.

These simple rules will help prevent costly inflation failures:

1. Make certain that tires are kept inflated to recommended pressure. Check at least once a week. Inflate when cool.

2. Never try to make old valve core do the job. Replace with a new one.

3. See that valve caps are kept screwed on finger-tight.

4. Check for slow leaks whenever air pressure shows a decided drop. Repair slow leaks immediately.

5. Do not reduce (bleed) the pressure which normally builds up after car is run. "Bleeding" of tires causes a dangerous increase in running temperature and the tires will be badly underinflated when cool.

Tips on how to get longest possible tread wear out of tires:

1. Keep tires properly inflated; check once a week.

2. Keep wheels in alignment. If tires are wearing unevenly, consult a competent tire serviceman regarding alignment of both front and rear wheels.


4. Rotate tires according to instructions in the operator's manual.

5. Keep brakes properly adjusted.

When a car has a tendency to shimmy or vibrate chances are that at least part of the cause is due to the wheels being out of balance. Another indication of improper wheel balance is rapid and spotty wear appearing on tires as a result of the road friction caused by "wobble" of the wheels. If unbalanced wheels are suspected, the car should be taken to a garage or service station which has proper balancing equipment.

Unbalanced wheels can cause these troubles:

1. Vibration may affect the steering mechanism.

2. Shock absorber links may be loosened.

3. Frame and body of the car may be loosened.

4. Grease and oil may be pounded out.

5. Uniform and effective brake application may be impaired.

Proper wheel balance pays many times over because it:

1. Reduces spotty wear

2. Improves tire mileage

3. Assures smooth and quiet car operation.

4. Reduces wear and tear on the car.

5. Makes for safe and comfortable driving.

Safe driving practices are the best assurance of obtaining maximum mileage from tires. Good drivers follow these tire-saving practices:

1. Maintain correct air pressure.

2. Do not drive over curbs, chuck holes or other pavement obstructions.

3. Avoid riding edge of pavement.

4. Avoid excessive speed at all times on all roads.

5. Start slowly and avoid spinning wheels.

6. Avoid sudden stops.

7. Check for soft and flat tires, unbalanced and misaligned wheels.

8. Drive safely at all times under all conditions.

In many areas of the United States it is necessary to equip cars with winter tires, or with chains for driving on snow or ice. If you should live in such an area, when a driver, consult a local tire dealer for his advice and counsel.

Tires are an important factor in the safe operation of cars on the highway. Caring for them properly at all times is one of the responsibilities you assume when you are granted the privilege of driving.
UNIT 2, SECTION IX  
TIREs AND THEIR CARE

LET'S DO

Each member is to do the following:

1. List three developments which have taken place over the years to make highway travel more enjoyable.
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________

2. List the three main classes of tires and give their life expectancy.
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________

3. What is meant by manufacturer's warranty? ____________________

4. How does the premium tire compare in quality to first and second line tires? __________________

5. List the essential tools needed in case of a blowout or puncture on the highway.
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________
   d. __________________________________________________________
   e. __________________________________________________________
   f. __________________________________________________________

6. Did you check the family car to see if the tools listed above are in it? _______________________

7. List the steps in the safe and efficient change of a tire.
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________
   d. __________________________________________________________
   e. __________________________________________________________
   f. __________________________________________________________
   g. __________________________________________________________
   h. __________________________________________________________
   i. __________________________________________________________
   j. __________________________________________________________

8. List three of the five simple rules on proper inflation.
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________

9. How can you tell if the wheels are not balanced properly?

10. List five of the nine tire-saving practices.
    a. __________________________________________________________
    b. __________________________________________________________
    c. __________________________________________________________
    d. __________________________________________________________
    e. __________________________________________________________

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UNIT 2, SECTION X

You and the hundreds of thousands in your age group are tomorrow’s leaders in the community, the state, the nation, and the world. And for many of you, as far as the highway is concerned, that “tomorrow” is approaching fast and your leadership role is about to begin. You can set the pace for safe, intelligent driving on America’s streets and highways. As teenagers you think fast, have quick reactions. You have a good sense of fairness and sportsmanship—all the attributes of a safe driver.

You’ve been thinking about driving for a long time. The chief aim of the 4-H Automotive Care and Safety Project is to help you fully realize your driving potential. No doubt you have considered many things during the previous year in preparing yourself to take over on the highway. Things like the importance of the motor vehicle to your way, the American way, of life; the safety responsibilities you’ll have as a driver, what makes a car run; how you can take care of it; what some of the costs are involving its maintenance and operation; and how to keep basic cost records.

When you achieve your long-standing ambition to drive you will join a large number of fellow Americans—some 125,100,000 of them. They’re all licensed drivers, entitled to operate motor-vehicles over the nation’s vast network of roads and highways. As a licensed driver, you will be sharing the highways with them.

You will come to know that driving is a privilege granted only to those who demonstrate, by passing examinations, that they are qualified. You will know, too, that your privilege can be taken away if you fail to live up to your responsibilities as a driver.

You will realize, probably more than ever before, the importance of good driving skills. And you will understand why these skills are important not only to you but to the other motorists who use the highways and streets with you.

As a teenager you possess an innate adaptability. You are sure it can be easy to acquire the skills making it possible for you to be a safe, successful driver. You are right; it can be easy. But, first you must know well three things:

1. Yourself
2. Rules of the Road
3. Your car.

As applied to driving, just what is meant by the expression, “knowing yourself”? How can you determine whether you really know yourself?

Knowing yourself is making sure in your own mind that you will do the things you should—and avoid the things you should not do—when you are driving. To know yourself make a self-analysis: Examine you, the potential driver.

Imagine yourself to be of age and a licensed driver. What kind of attitude do you have toward other motorists, toward pedestrians? Will you try to practice the “Golden Rule,” make courtesy your code of the road? Will you take stock of your driving habits; try conscientiously to correct those which are faulty? Will you mentally check and recheck your judgment as a driver, trying to measure improvement? Will you remind yourself that regardless of experience, the skillful driver always “plays it safe” on the highway?

It means driving defensively; staying alert with your mind and eyes always on the road and the traffic. It means looking ahead, anticipating what the other drivers will do and giving yourself ample time to react to other drivers’ errors to prevent an accident. It means expecting the unexpected.

CLOSURE TIME 27 SECONDS

A. TWO CARS: DRIVER HAS 27 SECONDS CLOSURE TIME TO OTHER CAR

CLOSURE TIME 7 SECONDS

B. TRACTOR AND CAR: DRIVER HAS LESS THAN 7 SECONDS CLOSURE TIME TO TRACTOR

The time a driver has to react to avoid an accident is much less when a slow moving vehicle is involved.
It means knowing you will start on trips on time to avoid a last minute rush, or avoid speeding to get where you are going. Or, if you get tired, or drowsy, or ill, to be willing to pull off the road for a rest. Or, to willingly regulate your driving in keeping with weather, road and traffic conditions.

Have you really learned the Rules of the Road, those laws and regulations adopted by the states to guide your actions when you drive? They simply set forth, with the force of law, the acts of courtesy and respect you normally should show others who share the road with you. Carefully obeying the letter and spirit of the rules will help protect yourself, your passengers and other highway users.

Finally in your quest of the skills that will make you a successful driver, how will you learn to "know your car"? By taking the time and effort before you drive it, especially if for any distance, to make certain it is mechanically sound and safe.

For your protection and that of your passengers and others with whom you will share the roads, you will want to do this periodically, or have it done, so your car will be maintained in proper condition at all times.

The items covered by the inspection required in a number of states, or those listed in the National Vehicle Safety-Check for Communities, provide a good guide for you. The latter includes brakes, lights, steering, tires, exhaust system, glass, windshield wipers, rear view mirrors and horn.

A great many safety features are engineered into the modern automobile. The manufacturers are continuously engaged in research to find new, more adequate safety devices for your increased protection in motoring and in case of accident. Installed in cars now is a wide variety of equipment designed to package the driver and his passengers in safety.

Real progress in designing safety into cars began about 30 years ago with the introduction of safety glass and the welded all-steel body. Much of the automotive equipment which we consider standard today was once a novel, original contribution to motoring safety. Windshield wipers, sun visors, defrosters, direction signals, improved tires, hydraulic brakes are some of the things counted among the pioneering devices to provide greater safety.

Far advanced from these standard items, many cars today roll off production lines equipped with devices such as recessed steering wheels, padded instrument panels, safety door locks, dual lighting systems, power brakes and power steering. These provide greater security, convenience, quiet and comfort.

In addition there are numerous other safety aids available on present day cars, or on an optional basis. Seat belts, for example, are now required as an effective means of preventing serious injury to driver and passengers in an accident. These can be installed at extra cost to the owners of older model cars.

The automotive industry works ceaselessly to further improve travel safety. Experiments are constantly being carried out in developing such items as crash padding, roll-over bars, shock absorbing bumpers, and a control stick that would replace the ordinary steering wheel, brakes and accelerator.

But the most important safety feature — and one which the manufacturer cannot build in — is you, the safe driver.

HOW SAFE ARE THE ROADS IN YOUR STATE?

MILEAGE DEATH RATES

Motor-vehicle traffic deaths per 100,000,000 vehicle miles

3.1

3.3

3.4

3.6

3.8

4.0

4.2

4.4

4.6

4.8

5.0

5.2

5.4

5.6

5.8

6.0

6.2

6.4

6.6

6.8

7.0

7.2

7.4

7.6

7.8

8.0

8.2

8.4

8.6

8.8

9.0

9.2

9.4

9.6

9.8

10.0

States above 10.0

Below 3.4 — 15 states

3.4 to 3.6 — 11 states

3.7 to 3.9 — 11 states

4.46 over — 13 states

Source: Rates estimated by the National Safety Council are based on data from state traffic authorities and the Federal Highway Administration.

Mileage rates may differ slightly from those published by individual states due to differences in mileage estimates.

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UNIT 2, SECTION X  HANDLING A CAR SAFELY ON THE ROAD

LET'S DO

Do individually or as a group.

*1. Clip from the daily newspaper for one week articles on motor vehicle accidents and from the information given, try to determine the real cause of each accident. Offer suggestions for the prevention of similar accidents in your community.

*2. Make, and display, an exhibit of "Rules of the Road" which you and other club members should follow.

3. Obtain a drivers' handbook from your State licensing authority and learn the "Rules of the Road" for your State.

4. Demonstrate the following for your club:
   a. Hand signals and their meaning.
   b. The meanings of different highway signs.
   c. What to do when you approach a stopped school bus.
   d. What to do when you hear a siren.
   e. How to parallel park.
   f. What you would do at an accident scene if you were involved.

5. Plan for a member of each of the following groups to meet with your club and discuss their activities and responsibilities as related to highway safety.
   a. State patrol
   b. Local police
   c. Local safety council or committee

6. Set up a safety checklist, then make a thorough check of your auto to find items which need attention. (See Section VI)

LET'S DISCUSS

You probably have not thought much before about the importance of good driving skills and desirable attitudes toward safety. Check your attitudes by answering the following quiz:

Part A
1. As a driver, do you think you would take chances in traffic "just for the fun of it?" __________
2. When driving would you behave differently than you do at home or at school? ________________
3. Would you willingly share the road even though you have the right of way? ________________
4. Do you think it would help to complain about poor drivers on the road? ________________

Part B
Answer "true" or "false" to the following questions:
1. Excessive speed costs money because of increased use of gas and oil. ______________________
2. The most important factor in safe driving is the operator. ______________________________
3. A flashing red signal means to slow down. _____________________________________________
4. When driving at 50 miles per hour, the safe following distance is two-car lengths. ______
5. Pedestrians in the crosswalk always have the right of way. ____________________________
6. Turn signal lights replace the use of hand signals in your state. ________________________

* This and other information could be placed on an attractive poster by a member of the project group and used for window displays and other 4-H presentations during the year.