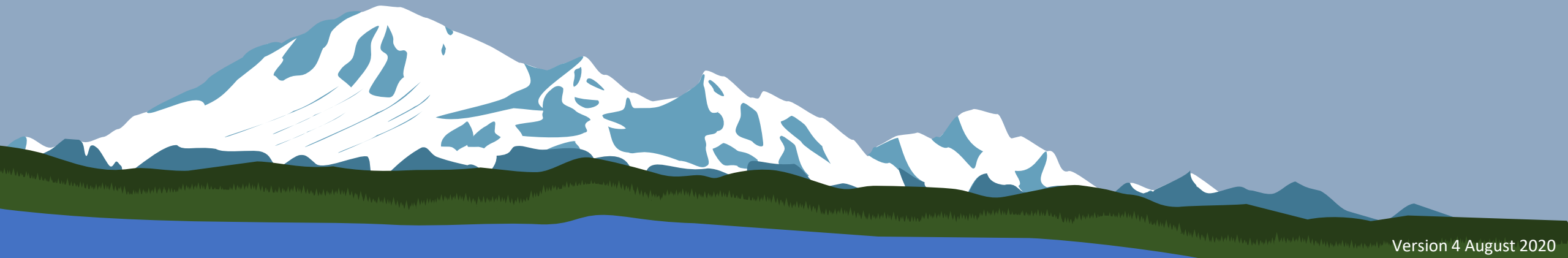
Automotive Maintenance Merit Badge



Version 4 August 2020

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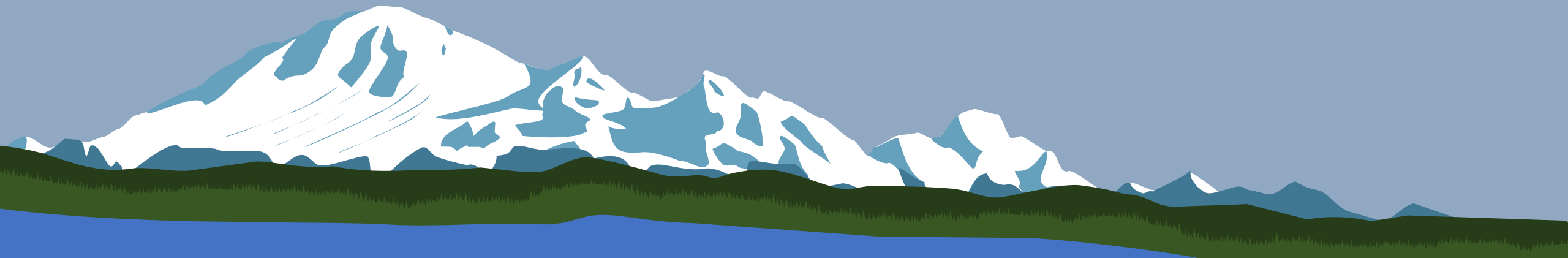

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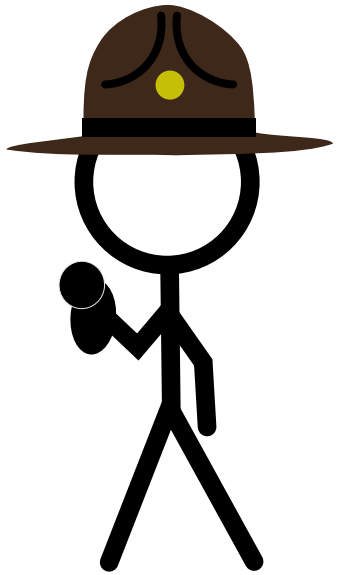

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Disclaimer

This PowerPoint slideshow was designed to be used to prepare scouts for the Automotive Maintenance Merit Badge and nothing more.

This slideshow is NOT intended to be used as automotive repair or maintenance reference.

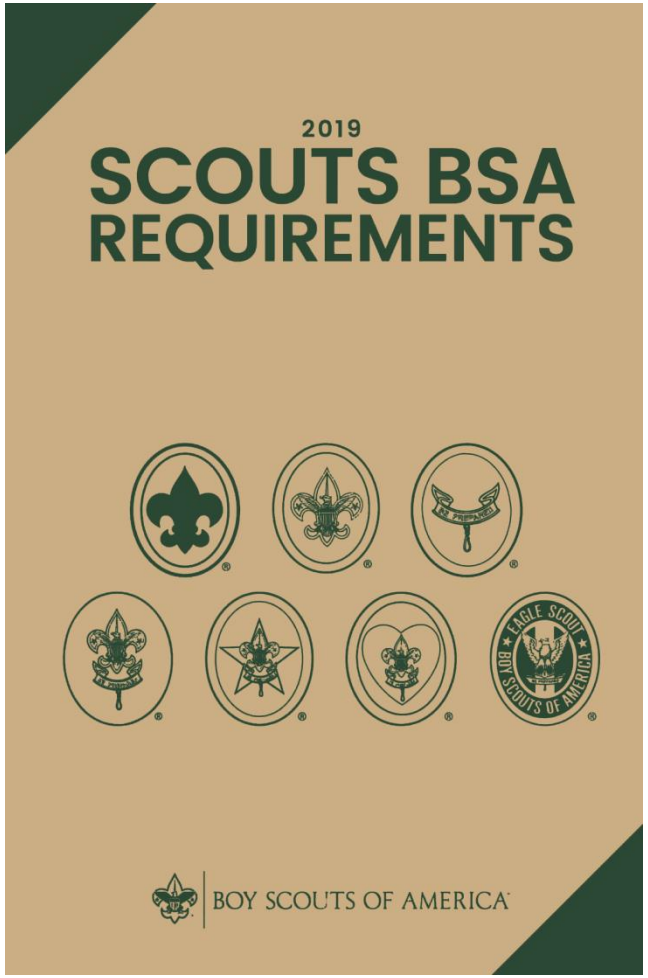
Proceed at your own risk and may god have mercy on your soul.

Merit Badge Requirements

Requirements

Requirements

- Merit Badge requirements dated: January 2017



Requirements

Requirements

1. Do the following:
    a. Explain to your counselor the hazards you are most likely to encounter during automotive maintenance activities, and what you should do to anticipate, help prevent, mitigate, or lessen these hazards.
    b. Discuss with your counselor the safety equipment, tools, and clothing used while checking or repairing a motor vehicle. Use this equipment, tools, and/or clothing (when needed or called for) in meeting the requirements for this merit badge.

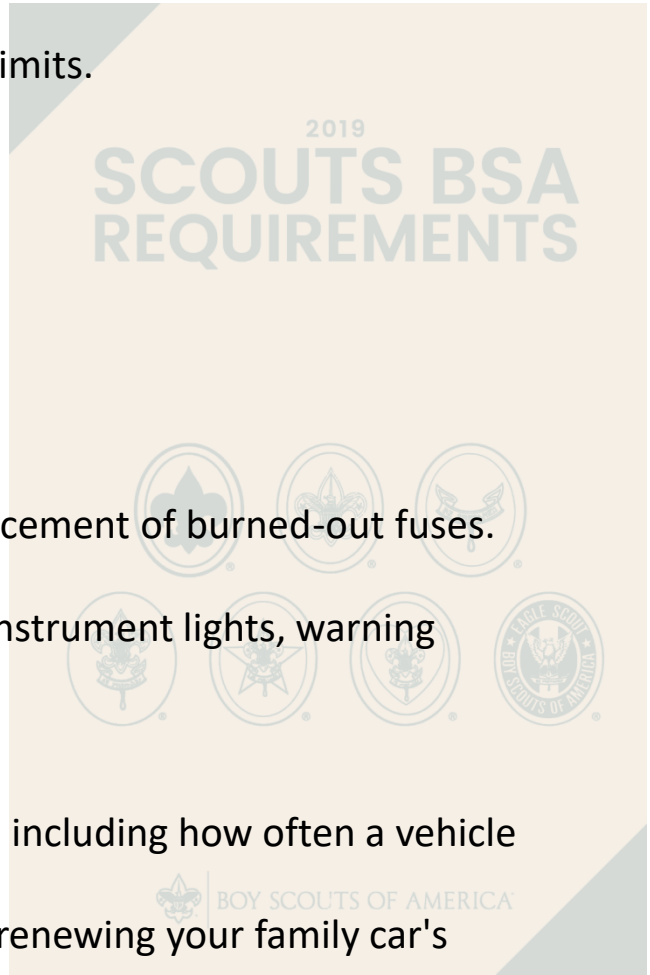
Requirements

Requirements

2. General Maintenance, Safety, and Registration

Do the following:

a. Review the maintenance chart in the owner's manual. Explain the requirements and time limits.
b. Demonstrate how to check the following:
    1. Brake Fluid
    2. Engine Oil
    3. Coolant
    4. Power steering fluid
    5. Windshield washer fluid
    6. Transmission fluid
    7. Battery fluid (if possible) and condition of the battery terminals.
c. Locate the fuse boxes; determine the type and size of fuses. Demonstrate the proper replacement of burned-out fuses.
d. Demonstrate how to check the condition and tension of belts and hoses.
e. Check the vehicle for proper operation of its lights, including the interior overhead lights, instrument lights, warning lights, and exterior bulbs.
f. Locate and check the air filter(s).
g. Explain the purpose, importance, and limitations of safety belts and passive restraints.
h. Find out the requirements for your state's emissions and safety inspections (as applicable), including how often a vehicle needs to be inspected.
i. Explain the importance of registering a vehicle and find out the annual registration fee for renewing your family car's registration.



Requirements

Requirements

3. Dashboard

Do the following:

a. Explain the function of the fuel gauge, speedometer, tachometer, oil pressure, and engine temperature gauge. Point out each one on the instrument cluster.
b. Explain the symbols that light up on the dashboard and the difference between the yellow and red symbols. Explain each of the indicators on the dashboard, using the owner's manual, if necessary.

4. Tires

Do the following:

a. Explain the difference between tire manufacturer's and vehicle manufacturer's specifications and show where to find them.
b. Demonstrate how to check pressure and properly inflate a tire. Check the spare tire and make sure it is ready for use.
c. Explain why wheel alignment is important to the life of a tire. Explain camber, caster, and toe-in adjustments on wheel alignment.
d. Explain the purpose of the lateral-wear bar indicator.
e. Explain how to dispose of old tires in accordance with local laws and regulations.

Requirements

Requirements

5. Engine

Do the following:

a. Explain how an internal combustion engine operates. Tell the differences between gasoline and diesel engines. Explain how a gasoline-electric hybrid vehicle is powered.
b. Explain the purpose of engine oil. Explain the API service code, the SAE number, and the viscosity rating.
c. Explain where to find the recommended oil type and the amount of oil to be used in the vehicle's engine.

6. Cooling system

Do the following:

a. Explain the need for coolant in the cooling system, and the importance of selecting the correct coolant type for a given vehicle.
b. Explain how to flush and change the engine coolant in the vehicle, and how to properly dispose of the used coolant.

Requirements

Requirements

7. Fuel system

Do the following:

a. Explain how the air and fuel systems work together and why it is necessary to have an air filter and fuel filter.
b. Explain how a fuel injection system works and how an on-board computer works with the fuel injection system.

8. Ignition and electrical systems

Do the following:

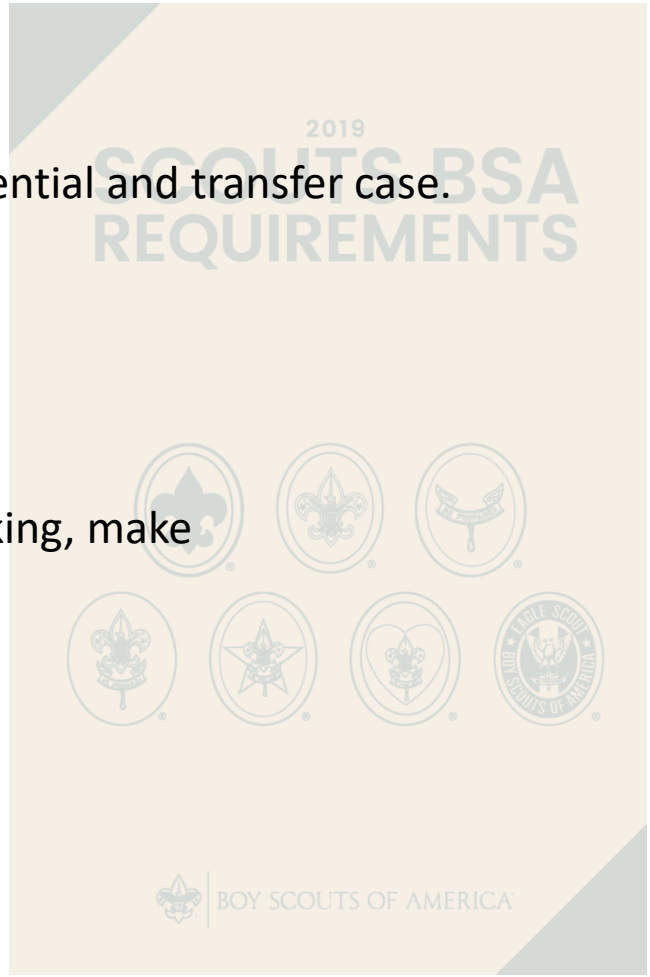
a. Diagram and explain the parts of the electrical system.
b. Explain the engine's firing order.
c. Explain the purpose of the spark gap.
d. Demonstrate how to safely connect jumper cables to your car battery.

Requirements

Requirements

9. Drive Train. Do the following:
   a. Diagram the drive train and explain the different parts.
   b. Explain the difference between automatic and standard transmissions.
   c. Explain the types of automatic transmission fluid.
   d. Explain the types of lubricants used in a standard transmission, and in the differential and transfer case.
   e. Explain the difference between front-wheel, rear-wheel, and four-wheel drive.

10. Brake System. Do the following:
   a. Explain the brake system (including antilock systems) and how it operates.
   b. Explain the differences between disc and drum systems.
   c. Demonstrate how to check the condition of a vehicle's brake system. After checking, make recommendations for repairs (if necessary)



Requirements

Requirements

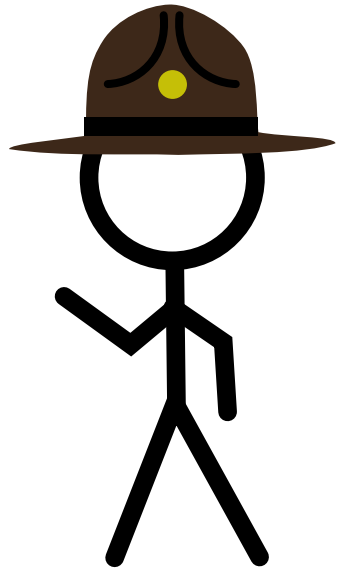
11. Do two of the following:
    a. Determine the value of three different vehicles you are interested in purchasing. One must be new and one must be used; the third vehicle can be new or used. For each vehicle, find out the requirements and cost of automobile insurance to include basic liability and options for collision, comprehensive, towing, and rental car. Using the three vehicles you chose and with your merit badge counselor's assistance, complete the operation/maintenance chart provided in the merit badge pamphlet. Use this information to determine the operating cost per mile for each vehicle, and discuss what you learn with your counselor.
    b. Choose a car cleaner and wax product for a vehicle you want to clean. Explain clear-coat paint and the precautions necessary for care. Clean the vehicle, both inside and out, and wax the exterior. Use a vinyl and rubber protectant (on vinyl tops, rubber door seals, sidewalls, etc.) and explain the importance of the protectant.
    c. Locate the manufacturer's jack. Use the jack to demonstrate how to engage the jack correctly on the vehicle, then change a tire correctly.
    d. Perform an oil filter and oil change on a vehicle. Explain how to properly dispose of the used oil and filter.

12. Find out about three career opportunities in the automotive industry. Pick one and find out about the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.

Merit Badge Intro

Merit Badge Intro

Instructor Introduction



Merit Badge Intro

Needed for Course

- Merit Badge Blue Card filled out and signed by your Scoutmaster
  - or other virtual agreement

- Merit Badge Pamphlet

- Scout Uniform

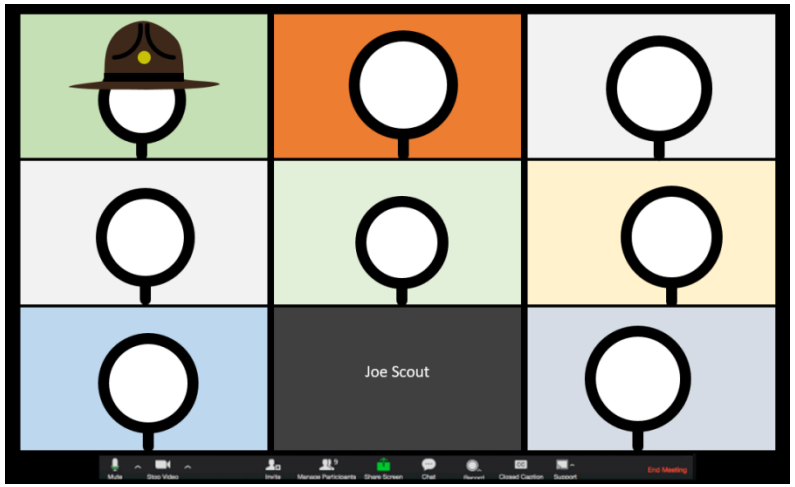
- A positive Scouting focus and attitude

Merit Badge Intro

Virtual Meetings

- Use your **REAL Name** and **Troop Number** if you want credit
  This is how we take attendance

- MUTE yourself unless speaking to the group



- Please turn your video on so we can see you

- No Chat SPAMMING

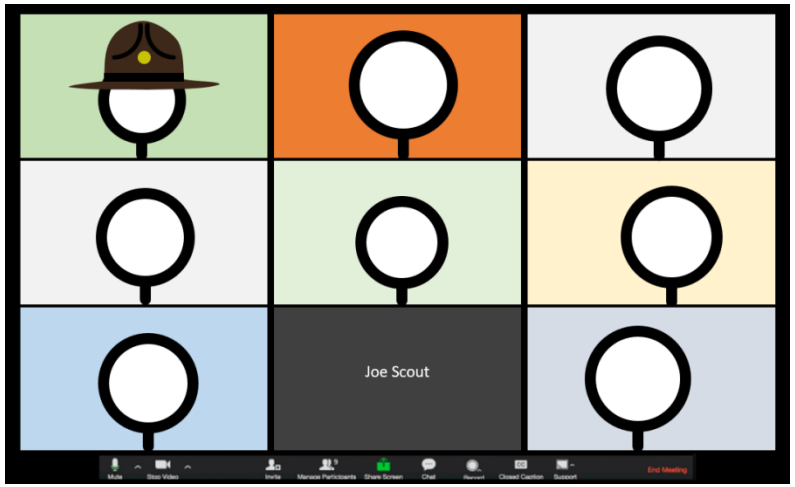
- If you need to go pee, go

- If something isn't working, please let us know!

Merit Badge Intro

Virtual Meetings

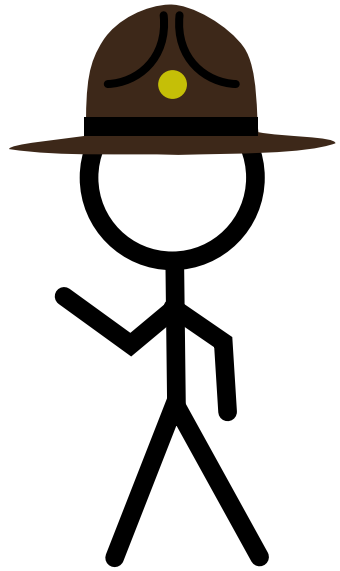
- We can’t do ALL the requirements virtually
- Option 1 – Partial Completion
- Option 2 – Completion – need proof
- Please send completed homework **AFTER** the final class
- Tell us who we should CC about completion



Merit Badge Intro

Course Overview

- We will cover most of the requirements for this Merit Badge in class
- We need proof that you completed these requirements
  - Please turn in a completed **Workbook** if possible
    This makes is easier on the counselor
  - If you can't complete a **Workbook**, please contact your councilor for alternatives

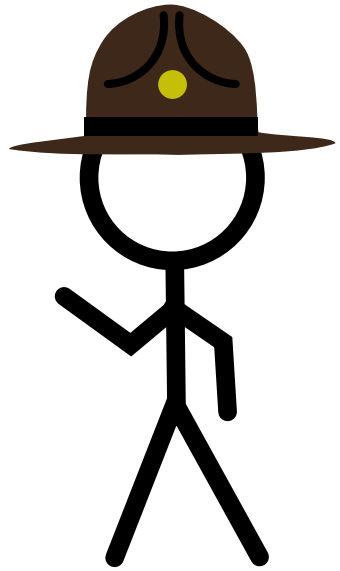


Merit Badge Intro

Safety

- We will cover some of the safety concern of Automotive Maintenance

Any work on a vehicle MUST be performed with an Experienced Adult



Merit Badge Intro

The Marvelous Driving Machine

On June 4, 1896, Henry Ford took a short drive around his Detroit neighborhood on his experimental quadricycle.

This vehicle was little more than a frame, a seat, a small engine, a steering bar, and four bicycle wheels.

With its 4-horsepower engine, the quadricycle could reach a top speed of 20 miles per hour.

By comparison, even the most basic cars today have 100-horsepower engines and can easily reach speeds of 100 miles per hour.

Merit Badge Intro

Automotive Maintenance

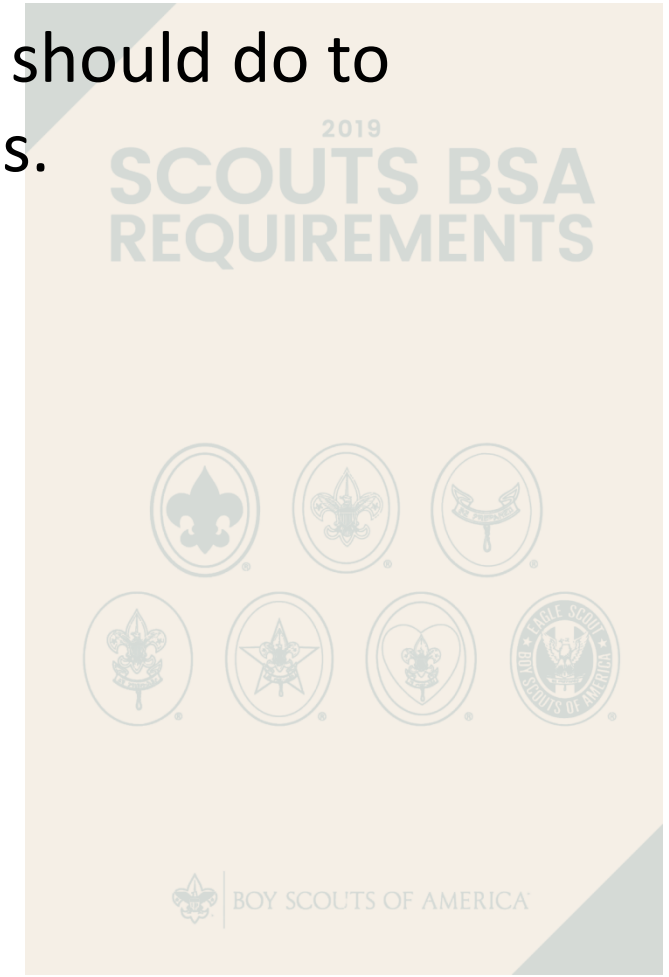
Ever since June 4, 1896, we've been working on vehicles

Hazards

Hazards

Requirement 1a – Hazards

Explain to your counselor the hazards you are most likely to encounter during automotive maintenance activities, and what you should do to anticipate, help prevent, mitigate, or lessen these hazards.



Hazards

Hazards

- Cuts and scraps
- Eye injuries
- Exposure to solvents, oils and other chemicals
- Lifting injuries
- Crush injuries

Hazards

Hazards – Cuts and Scraps

- Cuts and scraps can be frequent
- Avoid by wearing protective gear
  - Work gloves
  - Long sleeve overalls

Hazards

Hazards – Eye injuries

- Especially when working under a vehicle
  - Debris can fall in eyes
  - Oil and other liquids can get in eyes – sprays and splashes common
- Wear eye protection
- Have eye washing station nearby

Hazards

Hazards – Exposure to solvents, oils and other chemicals

- Generally poisonous if consumed
- Can cause permanent eye injury
- Can damage skin or be absorbed through the skin
- Avoid by:
  - Wearing gloves and eye protection
  - Wash up after working on vehicle

Hazards

Hazards – Lifting Injuries

- Common workplace injury
- Avoid by:
  - Bend at the knees
  - Don’t lift items that are too heavy – get help
  - Use lifting equipment

Hazards

Hazards – Crush Injuries

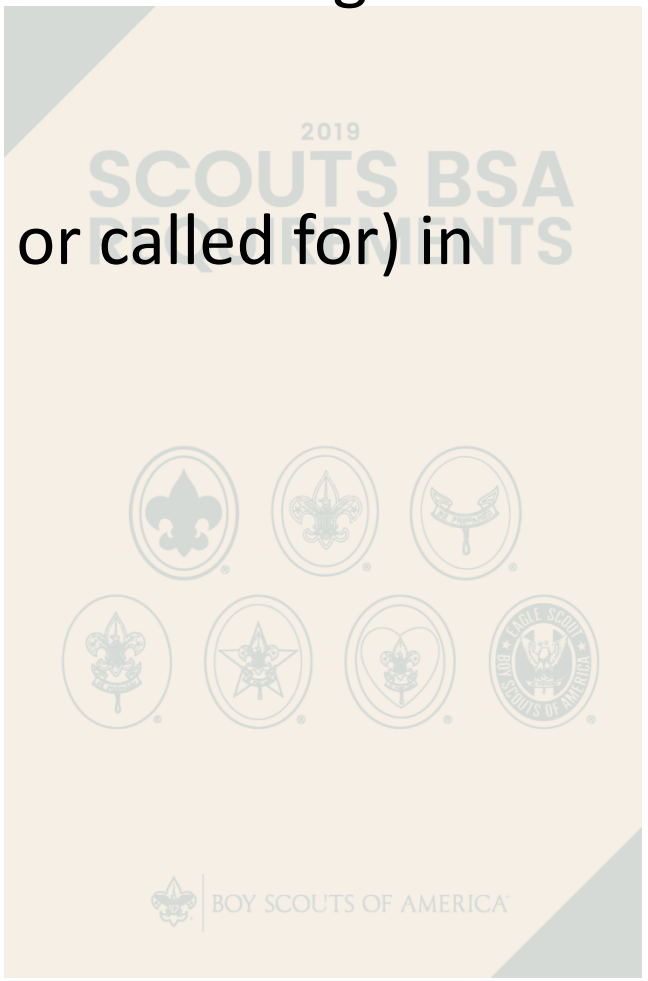
- Vehicle improperly jacked up can crush a person
- Heavy parts and tools can drop on hands and feet
- Avoid by:
  - Using properly jacking techniques – jack stands
  - Care around heavy equipment and parts

Hazards

Requirement 1b – Maintenance Safety

Discuss with your counselor the safety equipment, tools, and clothing used while checking or repairing a motor vehicle.

Use this equipment, tools, and/or clothing (when needed or called for) in meeting the requirements for this merit badge.



Hazards

Safety Gear

- Clothing
- Equipment

Hazards

Safety Gear – Clothing

- Clothing will protect you from scratches and scrapes
- Don’t wear loose/sloppy clothing that can get caught in moving parts
- Wear eyeglasses
- Note – clothing will get stained
  - Don’t wear your best clothing or scout uniform while working on vehicle

Hazards

Safety Gear – Jack Stands

- Never go under a vehicle that is not properly braced with jack stand(s)

Hazards

Safety Gear – Disconnect the Battery

- Disconnect negative battery cable if working in engine compartment
  - Protects you from electrical shock
  - Protects vehicle's electrical system from damage
  - Prevents electric fan from coming on while working on vehicle

General Maintenance, Safety, and Registration

General Maintenance, Safety, and Registration

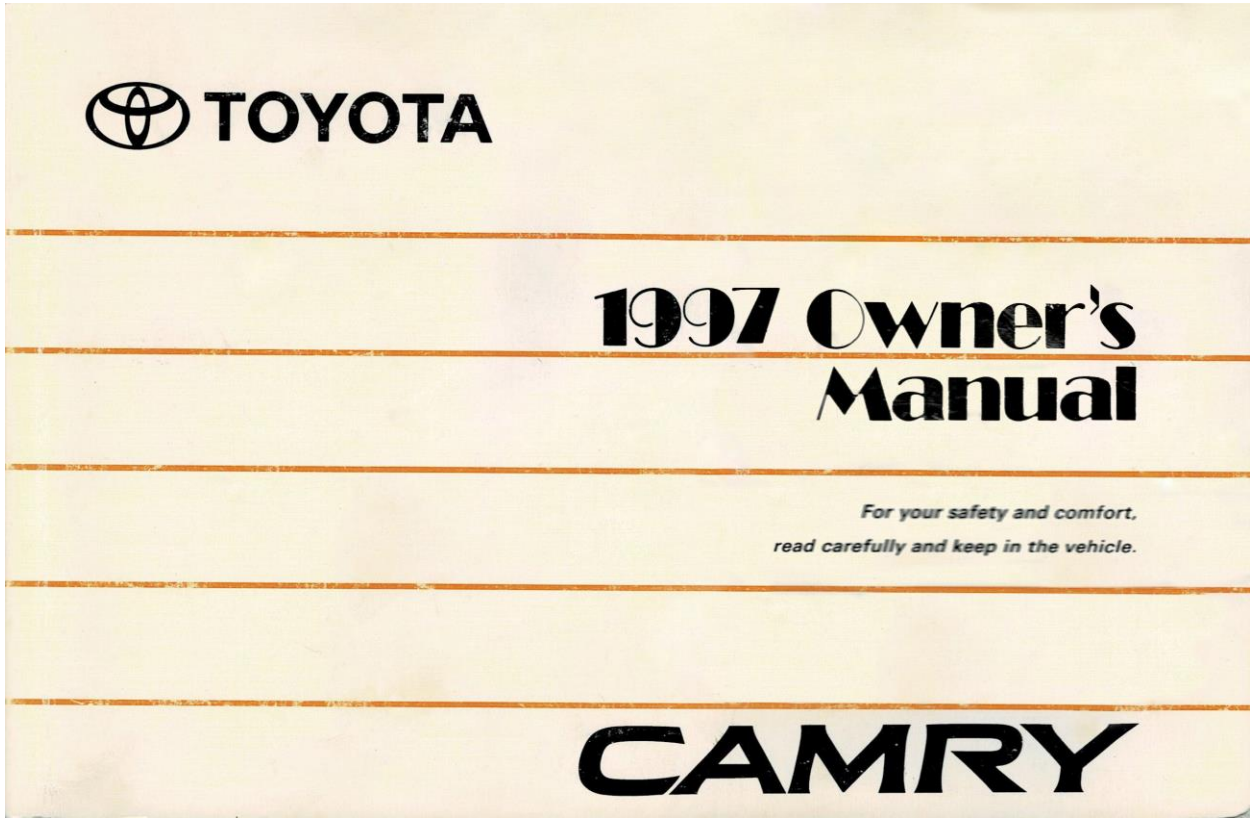
Requirement 2a - Owner’s Manual

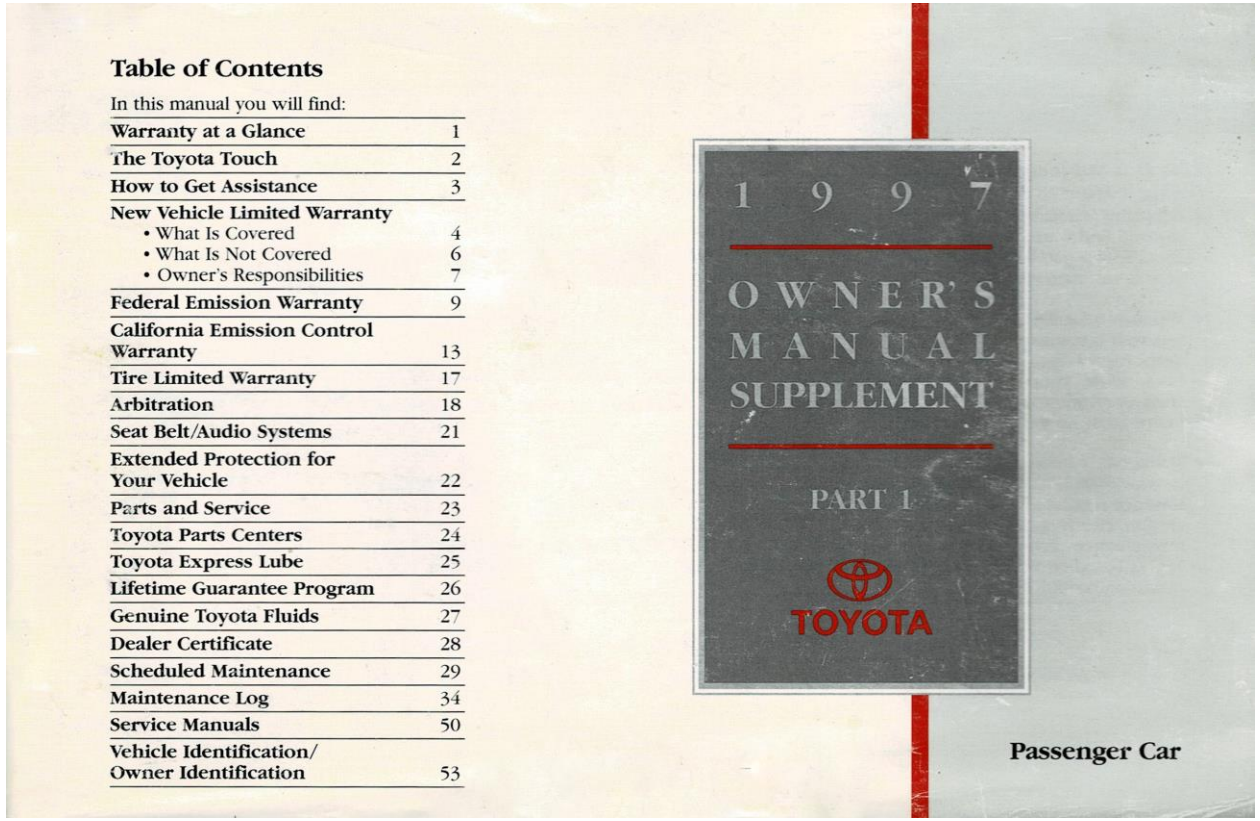
Review the maintenance chart in the owner's manual.

Explain the requirements and time limits.

General Maintenance, Safety, and Registration

Owner's Manual





General Maintenance, Safety, and Registration

Owner's Manual

Example of Owner's Manual

Introduction

The scheduled maintenance information included in this supplement is provided as a guide to assist you in getting the greatest ownership value from your Toyota, while helping to maximize its performance, safety, and reliability. In addition to scheduled maintenance, your Toyota also requires ongoing general maintenance which includes checking fluid levels and simple visual inspections for potential signs of trouble. These items are explained separately in the "General Maintenance" section of your *Owner's Manual*.

How much scheduled maintenance **your** Toyota requires depends on how you drive, as well as the environmental conditions in which you drive. The demands on vehicles can vary significantly depending on the driver, driving conditions, and geographic location. The following pages will assist you in determining the proper amount of maintenance for your Toyota so that you won't have to pay for more maintenance than your Toyota needs. **Note:** Failure to properly maintain your vehicle can result in your warranty being voided either in whole or in part; please refer to the "New Vehicle Limited Warranty – Owner's Responsibilities" section of this supplement for details.

The Scheduled Maintenance Log beginning on page 34 of this supplement allows you to easily identify the maintenance requirements at each mileage (or month) interval, while also providing a convenient place to document your vehicle's maintenance history. Properly maintaining your Toyota and documenting its maintenance history can also help increase its resale value.

How to Use the Scheduled Maintenance Log

Oil Change Intervals

The Scheduled Maintenance Log has been designed to provide you with the flexibility to follow either **5,000**-mile or **7,500**-mile oil change intervals, depending on your circumstances.

- Use **5,000**-mile oil change intervals to help ensure proper engine lubrication under most driving conditions **or** for the following:
  - You **primarily** operate your Toyota under the "Special Operating Conditions" described on page 30 of this supplement.
  - Your Toyota is turbocharged.*
- Use **7,500**-mile oil change intervals if you **primarily** operate your **non**-turbocharged Toyota under light, non-commercial duty for distances greater than five miles in temperate climates (above freezing and below 90° F).

If you choose **5,000**-mile oil change intervals, simply follow the instructions printed in the non-shaded boxes as shown in this example:

5,000 MILES

If you choose **7,500**-mile oil change intervals, simply follow the instructions printed in the shaded boxes as shown in this example:

7,500 MILES

The **5,000**- and **7,500**-mile intervals coincide at 15,000-mile increments; therefore, both the shaded and non-shaded boxes are shown as in this example:

15,000 MILES
15,000 MILES

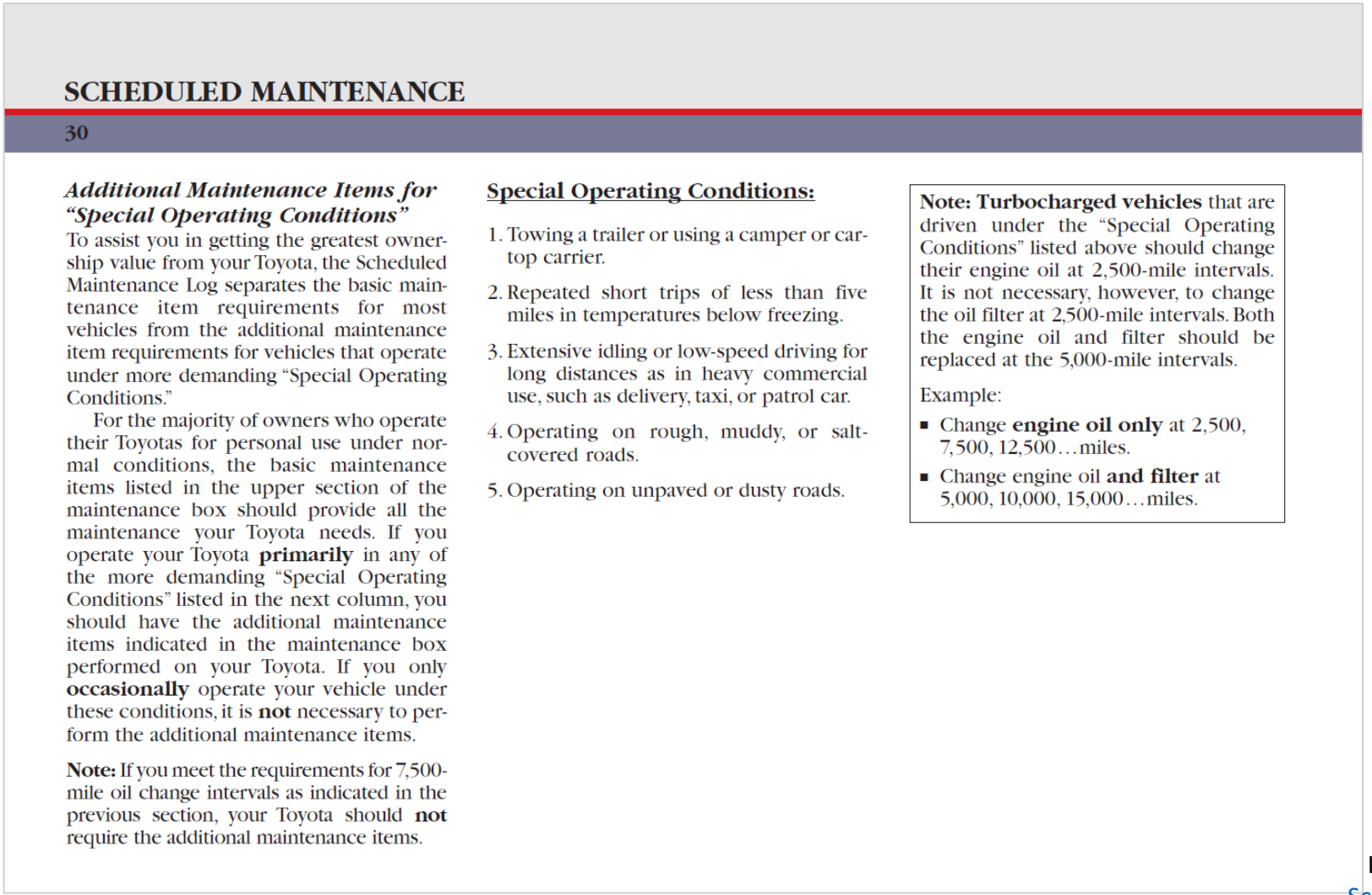
* **Note:** If a turbocharged Toyota is driven under the "Special Operating Conditions" described on page 30, then the oil change intervals should be further reduced to 2,500 miles.

Images Source: 1998 Toyota Camry Scheduled Maintenance Supplement

General Maintenance, Safety, and Registration

Owner's Manual

Example of Owner's Manual



SCHEDULED MAINTENANCE

30

Additional Maintenance Items for "Special Operating Conditions"

To assist you in getting the greatest ownership value from your Toyota, the Scheduled Maintenance Log separates the basic maintenance item requirements for most vehicles from the additional maintenance item requirements for vehicles that operate under more demanding "Special Operating Conditions."

For the majority of owners who operate their Toyotas for personal use under normal conditions, the basic maintenance items listed in the upper section of the maintenance box should provide all the maintenance your Toyota needs. If you operate your Toyota **primarily** in any of the more demanding "Special Operating Conditions" listed in the next column, you should have the additional maintenance items indicated in the maintenance box performed on your Toyota. If you only **occasionally** operate your vehicle under these conditions, it is **not** necessary to perform the additional maintenance items.

Note: If you meet the requirements for 7,500-mile oil change intervals as indicated in the previous section, your Toyota should **not** require the additional maintenance items.

Special Operating Conditions:

1. Towing a trailer or using a camper or car-top carrier.
2. Repeated short trips of less than five miles in temperatures below freezing.
3. Extensive idling or low-speed driving for long distances as in heavy commercial use, such as delivery, taxi, or patrol car.
4. Operating on rough, muddy, or salt-covered roads.
5. Operating on unpaved or dusty roads.

Note: Turbocharged vehicles that are driven under the "Special Operating Conditions" listed above should change their engine oil at 2,500-mile intervals. It is not necessary, however, to change the oil filter at 2,500-mile intervals. Both the engine oil and filter should be replaced at the 5,000-mile intervals.

Example:

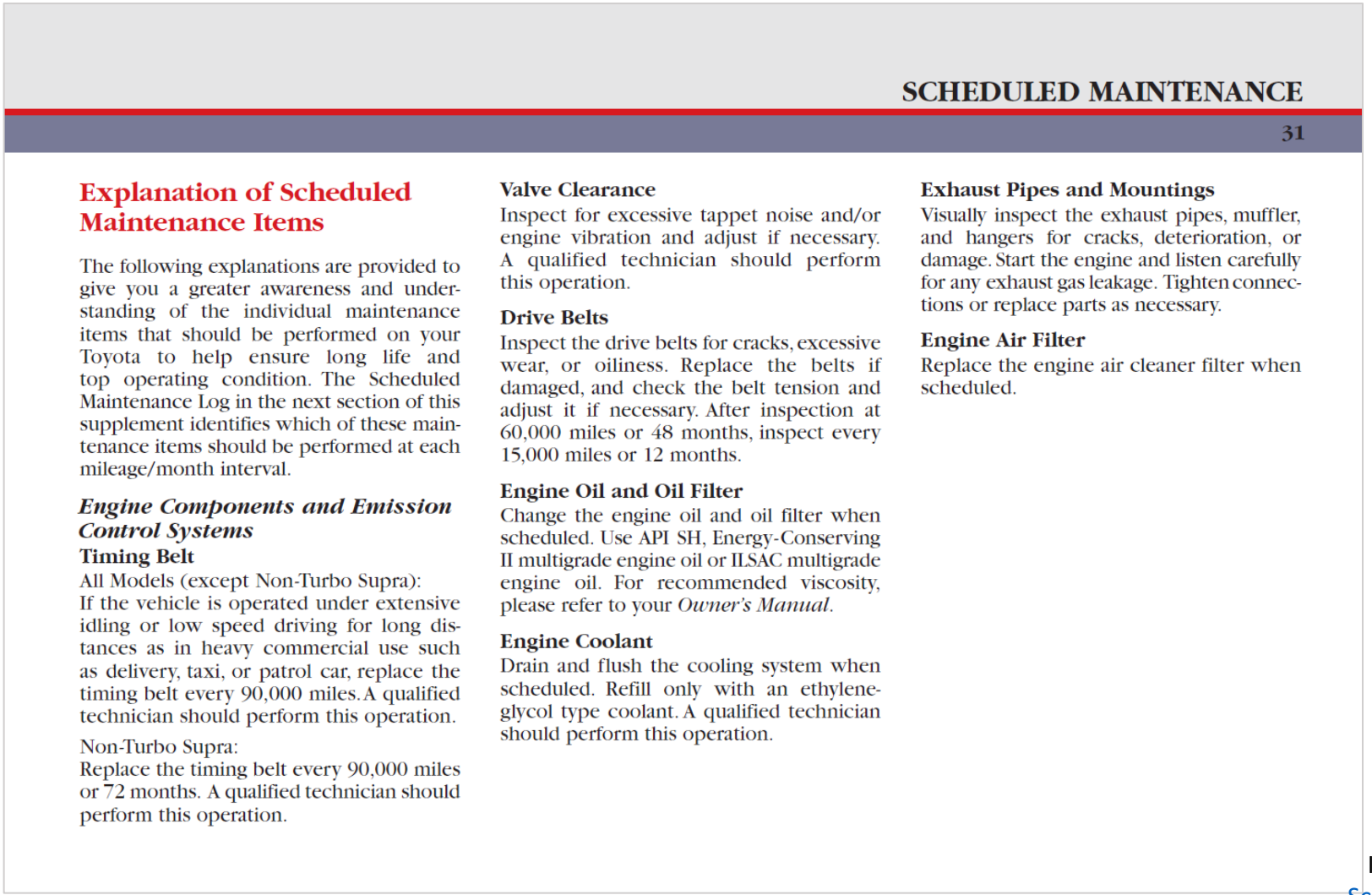
- Change **engine oil only** at 2,500, 7,500, 12,500…miles.
- Change engine oil **and filter** at 5,000, 10,000, 15,000…miles.

Images Source: 1998 Toyota Camry Scheduled Maintenance Supplement

General Maintenance, Safety, and Registration

Owner's Manual

Example of Owner's Manual



Explanation of Scheduled Maintenance Items

The following explanations are provided to give you a greater awareness and understanding of the individual maintenance items that should be performed on your Toyota to help ensure long life and top operating condition. The Scheduled Maintenance Log in the next section of this supplement identifies which of these maintenance items should be performed at each mileage/month interval.

Engine Components and Emission Control Systems

Timing Belt

All Models (except Non-Turbo Supra):
If the vehicle is operated under extensive idling or low speed driving for long distances as in heavy commercial use such as delivery, taxi, or patrol car, replace the timing belt every 90,000 miles. A qualified technician should perform this operation.

Non-Turbo Supra:
Replace the timing belt every 90,000 miles or 72 months. A qualified technician should perform this operation.

Valve Clearance

Inspect for excessive tappet noise and/or engine vibration and adjust if necessary. A qualified technician should perform this operation.

Drive Belts

Inspect the drive belts for cracks, excessive wear, or oiliness. Replace the belts if damaged, and check the belt tension and adjust it if necessary. After inspection at 60,000 miles or 48 months, inspect every 15,000 miles or 12 months.

Engine Oil and Oil Filter

Change the engine oil and oil filter when scheduled. Use API SH, Energy-Conserving II multigrade engine oil or ILSAC multigrade engine oil. For recommended viscosity, please refer to your *Owner's Manual*.

Engine Coolant

Drain and flush the cooling system when scheduled. Refill only with an ethylene-glycol type coolant. A qualified technician should perform this operation.

Exhaust Pipes and Mountings

Visually inspect the exhaust pipes, muffler, and hangers for cracks, deterioration, or damage. Start the engine and listen carefully for any exhaust gas leakage. Tighten connections or replace parts as necessary.

Engine Air Filter

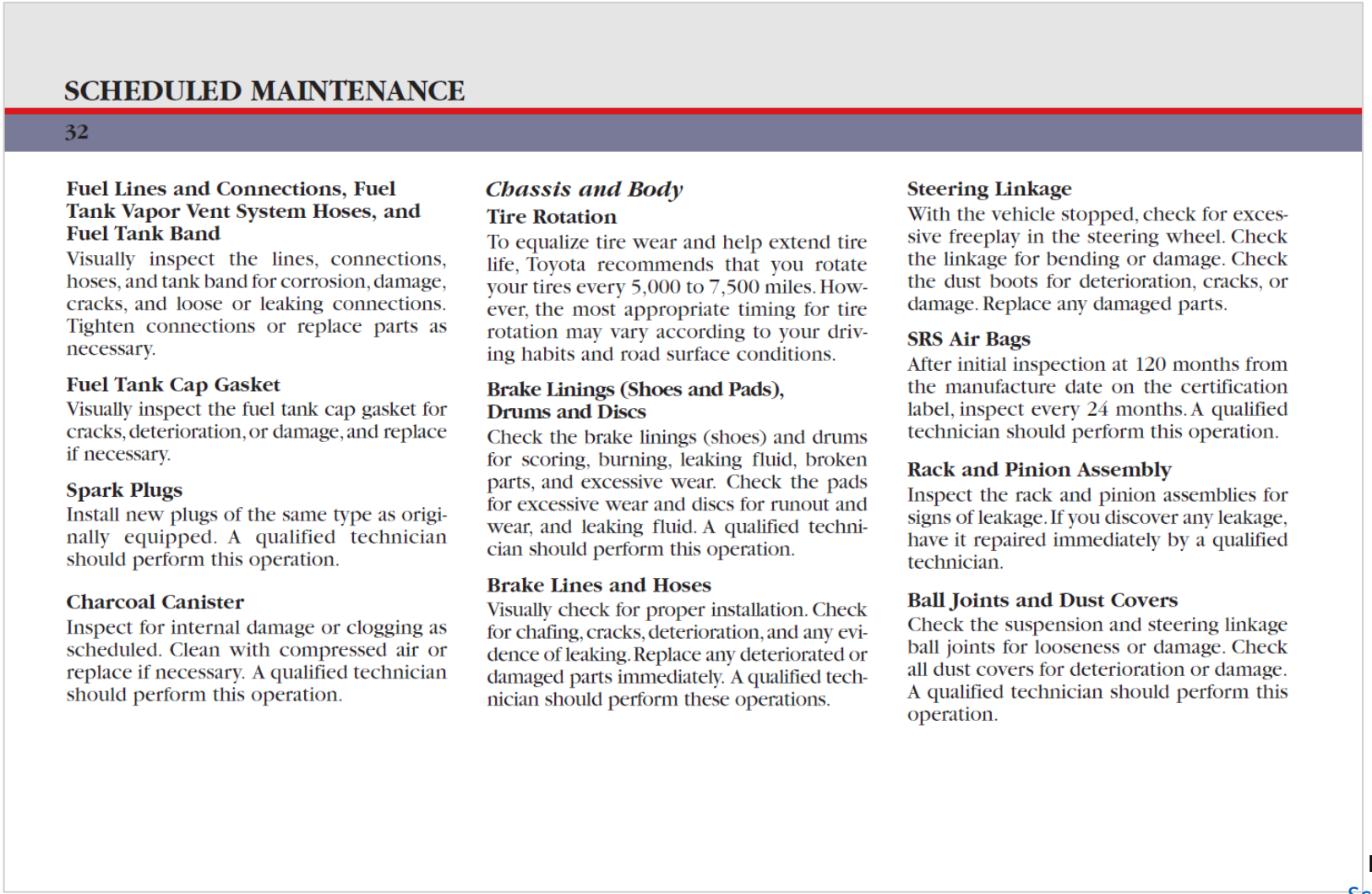
Replace the engine air cleaner filter when scheduled.

Images Source: 1998 Toyota Camry Scheduled Maintenance Supplement

General Maintenance, Safety, and Registration

Owner's Manual

Example of Owner's Manual



SCHEDULED MAINTENANCE

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Fuel Lines and Connections, Fuel Tank Vapor Vent System Hoses, and Fuel Tank Band
Visually inspect the lines, connections, hoses, and tank band for corrosion, damage, cracks, and loose or leaking connections. Tighten connections or replace parts as necessary.

Fuel Tank Cap Gasket
Visually inspect the fuel tank cap gasket for cracks, deterioration, or damage, and replace if necessary.

Spark Plugs
Install new plugs of the same type as originally equipped. A qualified technician should perform this operation.

Charcoal Canister
Inspect for internal damage or clogging as scheduled. Clean with compressed air or replace if necessary. A qualified technician should perform this operation.

Chassis and Body

Tire Rotation
To equalize tire wear and help extend tire life, Toyota recommends that you rotate your tires every 5,000 to 7,500 miles. However, the most appropriate timing for tire rotation may vary according to your driving habits and road surface conditions.

Brake Linings (Shoes and Pads), Drums and Discs
Check the brake linings (shoes) and drums for scoring, burning, leaking fluid, broken parts, and excessive wear. Check the pads for excessive wear and discs for runout and wear, and leaking fluid. A qualified technician should perform this operation.

Brake Lines and Hoses
Visually check for proper installation. Check for chafing, cracks, deterioration, and any evidence of leaking. Replace any deteriorated or damaged parts immediately. A qualified technician should perform these operations.

Steering Linkage
With the vehicle stopped, check for excessive freeplay in the steering wheel. Check the linkage for bending or damage. Check the dust boots for deterioration, cracks, or damage. Replace any damaged parts.

SRS Air Bags
After initial inspection at 120 months from the manufacture date on the certification label, inspect every 24 months. A qualified technician should perform this operation.

Rack and Pinion Assembly
Inspect the rack and pinion assemblies for signs of leakage. If you discover any leakage, have it repaired immediately by a qualified technician.

Ball Joints and Dust Covers
Check the suspension and steering linkage ball joints for looseness or damage. Check all dust covers for deterioration or damage. A qualified technician should perform this operation.

Images Source: 1998 Toyota Camry Scheduled Maintenance Supplement

General Maintenance, Safety, and Registration

Owner's Manual

Example of Owner's Manual

Drive Shaft Boots
Check the drive shaft boots and clamps for cracks, deterioration, or damage. Replace any damaged parts and, if necessary, repack the grease. For Camry, Avalon, and Supra, also re-torque the flange bolts (drive shaft to differential or side gear shaft). A qualified technician should perform these operations.

Manual Transmission Oil
Inspect each component for signs of leakage when scheduled. If you discover any leakage, have it repaired by a qualified technician immediately. If the vehicle is operated under the "Special Operating Conditions" defined on page 30 of this supplement, change the oil when scheduled.

Automatic Transmission and Differential Oil
Inspect each component for signs of leakage when scheduled. If you discover any leakage, have it repaired by a qualified technician immediately. If the vehicle is operated under the "Special Operating Conditions" defined on page 30 of this supplement, change the oil when scheduled.

Limited-Slip Differential Oil
Inspect every 15,000 miles or 12 months. Replace every 60,000 miles or 48 months. A qualified technician should perform this operation.

Wheel Bearing Grease
Repack the wheel bearings with wheel bearing grease.

Bolts and Nuts on Chassis and Body
If the vehicle is operated under the "Special Operating Conditions" defined on page 30 of this supplement, re-tighten the seat mounting bolts and front and rear suspension member retaining bolts to specified torque.

Images Source: 1998 Toyota Camry Scheduled Maintenance Supplement

General Maintenance, Safety, and Registration

Owner's Manual

Example of Owner's Manual

5,000 Miles or 4 Months*

- ☐ Replace engine oil and oil filter
- ☐ Rotate tires

Additional Maintenance Items for Special Operating Conditions:
Please refer to page 30 of this supplement to determine if your Toyota requires the additional maintenance items.

- ☐ Inspect the following:
  - __ Air filter
  - __ Brake: linings, discs/drums
  - __ Steering linkages
  - __ Ball joints and dust covers
  - __ Drive shaft boots (re-torque flange bolts)
  - __ Body/chassis nuts and bolts

Dealer Service Verification

Date: _____

Mileage: _____

10,000 Miles or 8 Months*

- ☐ Replace engine oil and oil filter
- ☐ Rotate tires

Additional Maintenance Items for Special Operating Conditions:
Please refer to page 30 of this supplement to determine if your Toyota requires the additional maintenance items.

- ☐ Inspect the following:
  - __ Air filter
  - __ Brake: linings, discs/drums
  - __ Steering linkages
  - __ Ball joints and dust covers
  - __ Drive shaft boots (re-torque flange bolts)
  - __ Body/chassis nuts and bolts

Dealer Service Verification

Date: _____

Mileage: _____

7,500 Miles or 6 Months*

- ☐ Replace engine oil and oil filter
- ☐ Rotate tires

Dealer Service Verification

Date: _____

Mileage: _____

*Use the white background boxes to follow 5,000-mile oil change intervals or the shaded background boxes to follow 7,500-mile oil change intervals. Please refer to page 29 of this supplement for further information and to determine which interval is right for your driving circumstances.

5,000-Mile Oil Change Intervals **7,500-Mile Oil Change Intervals**

15,000 Miles or 12 Months*

15,000 Miles or 12 Months*

- ☐ Replace engine oil and oil filter
- ☐ Rotate tires
- ☐ Inspect the following:
  - __ Exhaust pipes and mountings
  - __ Brake: linings, discs/drums, lines, hoses
  - __ Steering linkages
  - __ Rack and pinion assy. for leakage
  - __ Ball joints and dust covers
  - __ Drive shaft boots (re-torque flange bolts)
  - __ Automatic transmission and differential oil
  - __ Limited-slip differential oil (Supra)

Additional Maintenance Items for Special Operating Conditions:
Please refer to page 30 of this supplement to determine if your Toyota requires the additional maintenance items.

- ☐ Inspect air filter
- ☐ Replace automatic transmission and differential oil
- ☐ Inspect body/chassis nuts and bolts

Dealer Service Verification

Date: _____

Mileage: _____

Images Source: [1998 Toyota Camry Scheduled Maintenance Supplement]

General Maintenance, Safety, and Registration

Requirement 2b - General Maintenance

Demonstrate how to check the following:

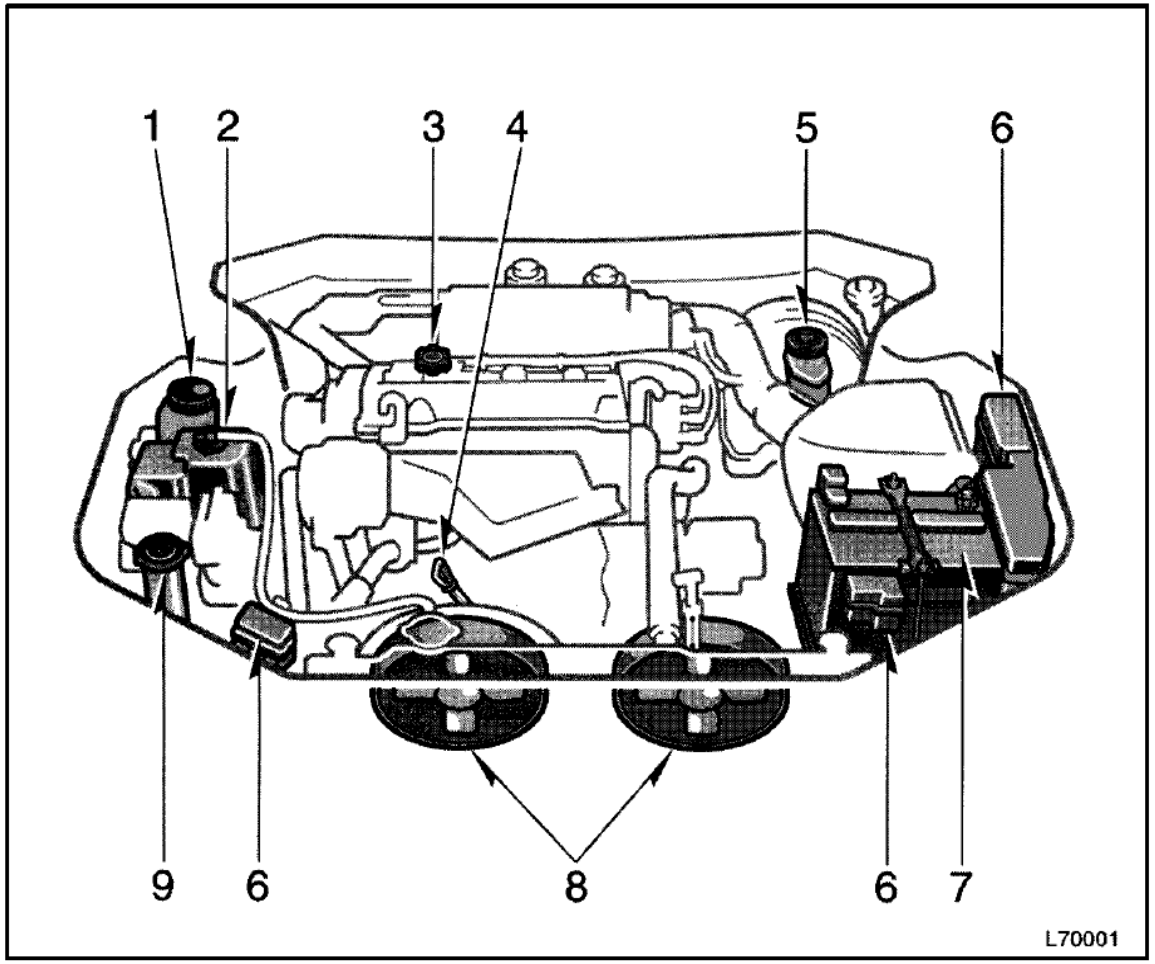
1. Brake Fluid
2. Engine Oil
3. Coolant
4. Power steering fluid
5. Windshield washer fluid
6. Transmission fluid
7. Battery fluid (if possible) and condition of the battery terminals.

General Maintenance, Safety, and Registration

Example of Owner's Manual

Engine compartment overview

▶5S-FE engine



1. Power steering fluid reservoir
2. Engine coolant reservoir
3. Engine oil filler cap
4. Engine oil level dipstick
5. Brake fluid reservoir
6. Fuse blocks
7. Battery
8. Engine cooling fans
9. Windshield washer fluid tank

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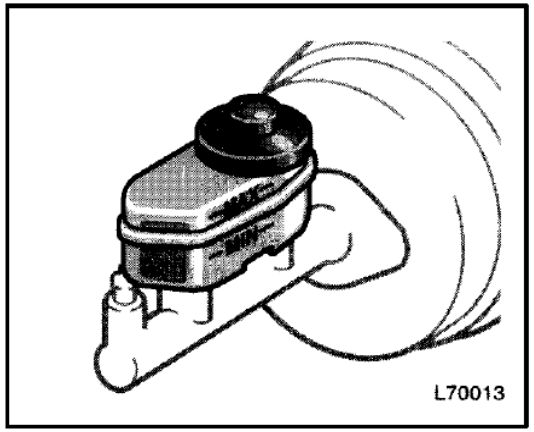
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Brake Fluid

Example of Owner's Manual

Checking brake fluid



To check the fluid level, simply look at the see through reservoir. The level should be between the "MAX" and "MIN" lines on the reservoir.

It is normal for the brake fluid level to go down slightly as the brake pads wear. So be sure to keep the reservoir filled.

If the reservoir needs frequent refilling, it may indicate a serious mechanical problem.

If the level is low, add SAE J1703 or FMVSS No. 116 DOT 3 brake fluid to the brake reservoir.

Remove and replace the reservoir cover by hand.

Use only newly opened brake fluid. Once opened, brake fluid absorbs moisture from the air, and excess moisture can cause a dangerous loss of braking.

⚠ CAUTION

Take care when filling the reservoir because brake fluid can harm your eyes and damage painted surfaces. If fluid gets in your eyes, flush your eyes with clean water.

NOTICE

If you spill the fluid, be sure to wash it off with water to prevent it from damaging the parts or paint.

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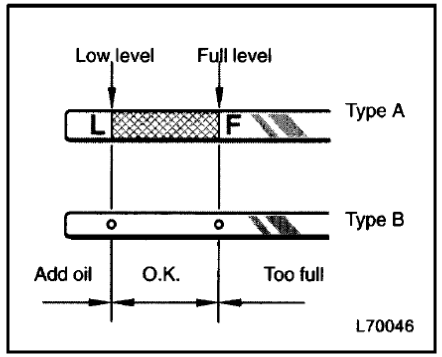
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Engine Oil

Example of Owner's Manual

Checking the engine oil level



With the engine at operating temperature and turned off, check the oil level on the dipstick.

1. To get a true reading, the vehicle should be on a level spot. After turning off the engine, wait a few minutes for the oil to drain back into the bottom of the engine.
2. Pull out the dipstick, and wipe it clean with a rag.
3. Reinsert the dipstick—push it in as far as it will go, or the reading will not be correct.
4. Pull the dipstick out and look at the oil level on the end.

⚠ CAUTION

Be careful not to touch the hot exhaust manifold.

If the oil level is below or only slightly above the low level line, add engine oil of the same type as already in the engine.

Remove the oil filter cap and add engine oil in small quantities at a time, checking the dipstick.

The approximate quantity of oil needed to fill between the low level line and the full level on the dipstick is indicated below for reference.

When the level reaches within the correct range, install the filler cap hand-tight.

Oil quantity, L (qt., Imp. qt.):

5S-FE engine	0.7 (0.7, 0.6)
1MZ-FE engine	1.5 (1.6, 1.3)

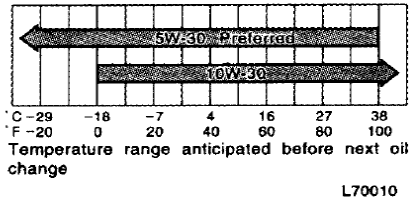
NOTICE

- ***Avoid overfilling, or the engine could be damaged.***
- ***Check the oil level on the dipstick once again after adding the oil.***

Engine oil selection

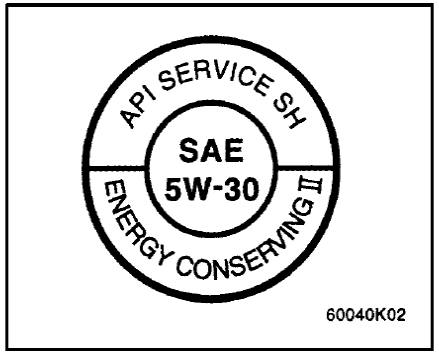
Use API SH, "Energy-Conserving II" multigrade engine oil or ILSAC multigrade engine oil.

Recommended viscosity (SAE):

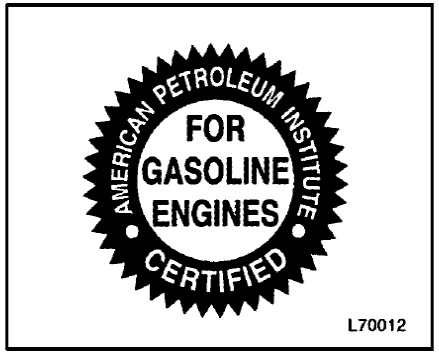


SAE 5W-30 is the best choice for your vehicle, for good fuel economy and good starting in cold weather.

If you use SAE 10W-30 engine oil in extremely low temperatures, the engine may become difficult to start, so SAE 5W-30 engine oil is recommended.



API service symbol



ILSAC certification mark

Oil identification marks

Either or both API registered marks are added to some oil containers to help you select the oil you should use.

The API Service Symbol is located anywhere on the outside of the container.

The top portion of the label shows the oil quality by API (American Petroleum Institute) designations such as SH. The center portion of the label shows the SAE viscosity grade such as SAE 5W-30. "Energy-Conserving II" shown in the lower portion, indicates that the oil has fuel-saving capabilities. Oils marked "Energy-Conserving II" will have higher fuel-saving capabilities than oil marked "Energy-Conserving".

The ILSAC (International Lubricant Standardization and Approval Committee) Certification Mark is displayed on the front of the container.

Images Source: [1997 Toyota Camry Owner's Manual]

General Maintenance, Safety, and Registration

Coolant

Checking the engine coolant level

Look at the see-through coolant reservoir when the engine is cold. The coolant level is satisfactory if it is between the "FULL" and "LOW" lines on the reservoir. If the level is low, add ethylene-glycol type coolant.

The coolant level in the reservoir will vary with engine temperature. However, if the level is on or below the "LOW" line, add coolant. Bring the level up to the "FULL" line.

Use only ethylene-glycol type coolant. See information in the next column.

If the coolant level drops within a short time after replenishing, there may be a leak in the system. Visually check the radiator, hoses, radiator cap and drain cock and water pump.

If you can find no leak, have your Toyota dealer test the cap pressure and check for leaks in the cooling system.

⚠ CAUTION

To prevent burning yourself, do not remove the radiator cap when the engine is hot.

Example of Owner's Manual

Coolant type selection

Your coolant must contain ethylene-glycol antifreeze. In addition to preventing freezing and subsequent damage to the engine, this will also prevent corrosion. Further supplemental inhibitors or additives are neither needed nor recommended.

Read the antifreeze container for information on freeze protection. Follow the manufacturer's directions for how much to mix with water. The total capacity of the cooling system is given in Part 8. We recommend 50% solution be used for your Toyota, or a sufficient quantity to provide protection to about -35°C (-31°C).

NOTICE

Do not use alcohol type antifreeze or plain water alone.

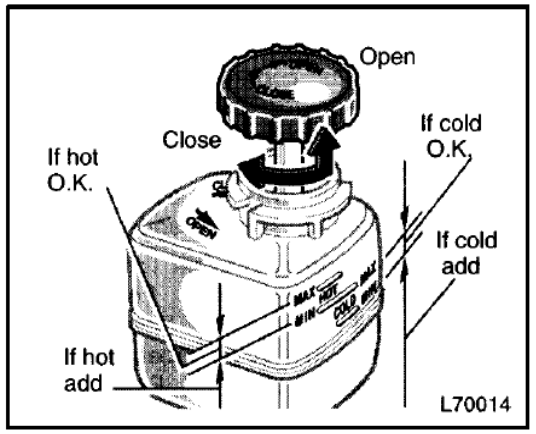
Images Source: [1997 Toyota Camry Owner's Manual]

General Maintenance, Safety, and Registration

Power Steering Fluid

Example of Owner's Manual

Checking power steering fluid



Check the fluid level through the reservoir. If necessary, add automatic transmission fluid DEXRON®II or III.

If the vehicle has been driven around 80 km/h (50 mph) for 20 minutes (a little more in frigid temperatures), the fluid is hot (60°C—80°C or 140°F—175°F). You may also check the level when the fluid is cold (about room temperature, 10°C—30°C or 50°F—85°F) if the engine has not been run for about five hours.

Clean all dirt from outside of the reservoir tank and look at the fluid level. If the fluid is cold, the level should be in the "COLD" range. Similarly, if it is hot, the fluid level should be in the "HOT" range. If the level is at the low side of either range, add automatic transmission fluid DEXRON®-II or III to bring the level within range.

To remove the filler cap, turn it counterclockwise and lift up. To reinstall it, turn it clockwise. After replacing the filler cap, visually check the steering box case, vane pump and hose connections for leaks or damage.

⚠ CAUTION

The reservoir tank may be hot so be careful not to burn yourself.

NOTICE

Avoid overfilling, or the power steering could be damaged.

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Windshield Washer Fluid

Example of Owner's Manual

Adding washer fluid

If any washer does not work or low windshield washer fluid level warning light comes on, the washer tank may be empty. Add washer fluid.

You may use plain water as washer fluid. However, in cold areas where temperatures range below freezing point, use washer fluid containing antifreeze. This product is available at your Toyota dealer and most auto parts stores. Follow the manufacturer's directions for how much to mix with water.

NOTICE

Do not use engine antifreeze or any other substitute because ti may damage your vehicle's paint.

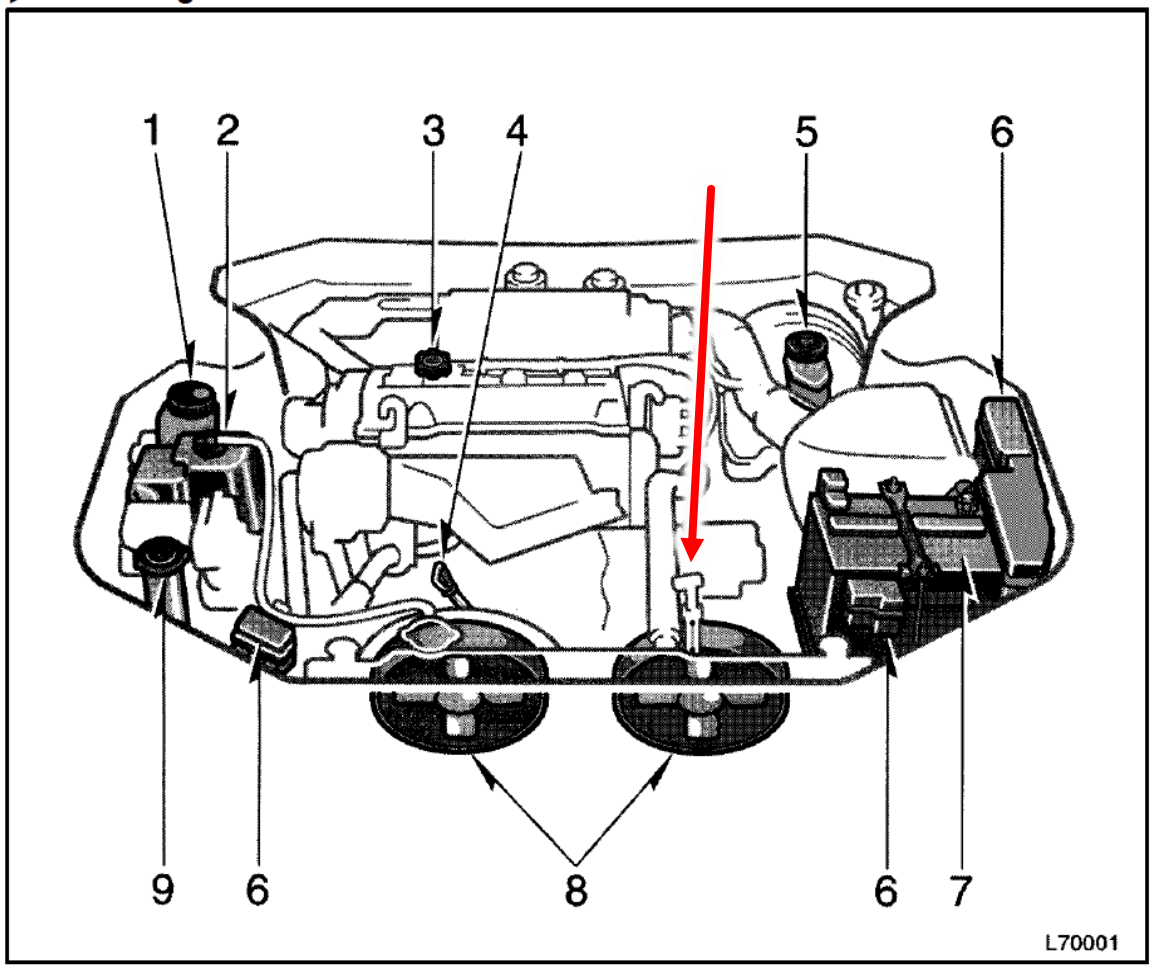
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Transmission Fluid

Example of Owner's Manual

▶5S-FE engine



1. Power steering fluid reservoir
2. Engine coolant reservoir
3. Engine oil filler cap
4. Engine oil level dipstick
5. Brake fluid reservoir
6. Fuse blocks
7. Battery
8. Engine cooling fans
9. Windshield washer fluid tank

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

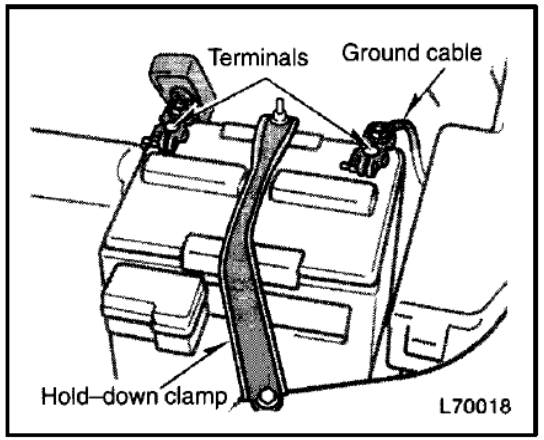
Transmission Fluid

- Transmission Fluid check may not be found in the owner's manual
- Check repair manual for your specific vehicle
- Some transmissions do NOT have a dip stick
- To check
  - Warm up engine – the transmission fluid will expand when warmed
  - Park on a level surface
  - Check dipstick
    - Full, low or fill?
    - Color?
      - Should be reddish pink
      - Brownish red – may need to be replaced
      - Dark brown or black – not good

General Maintenance, Safety, and Registration

Battery Fluid and Terminals Example of Owner's Manual

—Checking battery exterior



Check the battery for corroded or loose terminal connections, cracks, or loose hold-down clamp.

a. If the battery is corroded, wash it off with a solution of warm water and baking soda. Coat the outside of the terminals with grease to prevent further corrosion.

b. If the terminal connections are loose, tighten their clamp nuts–but do not overtighten.

c. Tighten the hold-down clamp only enough to keep the battery firmly in place. Overtightening may damage the battery case.

NOTICE

- ***Be sure the engine and all accessories are off before performing maintenance.***
- ***When checking the battery, remove the ground cable from the negative terminal ("-" mark) first and reinstall it last.***
- ***Be careful not to cause a short circuit with tools.***
- ***Take care no solution gets into the battery when washing it.***

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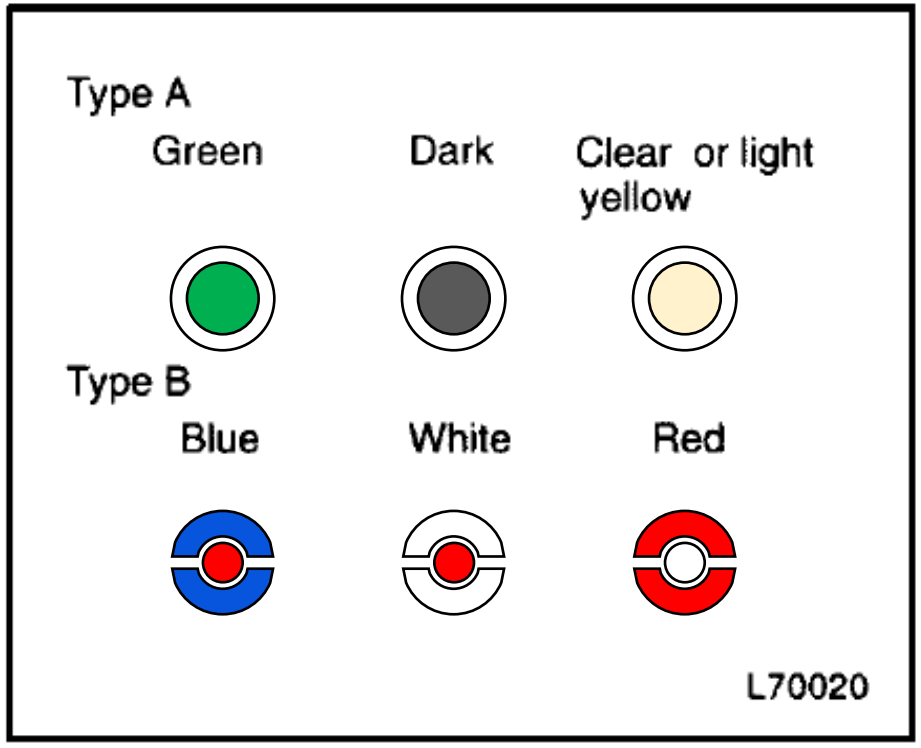
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Battery Fluid and Terminals Example of Owner's Manual



CHECKING BY THE HYDROMETER

Check the battery condition by the hydrometer color.

Maintenance type battery

Hydrometer color		Condition
Type A	Type B	
GREEN	BLUE	Good
DARK	WHITE	Charging necessary. Have battery checked by your Toyota dealer.
CLEAR or LIGHT YELLOW	RED	Add distilled water*

*: See "ADDING DISTILLED WATER".

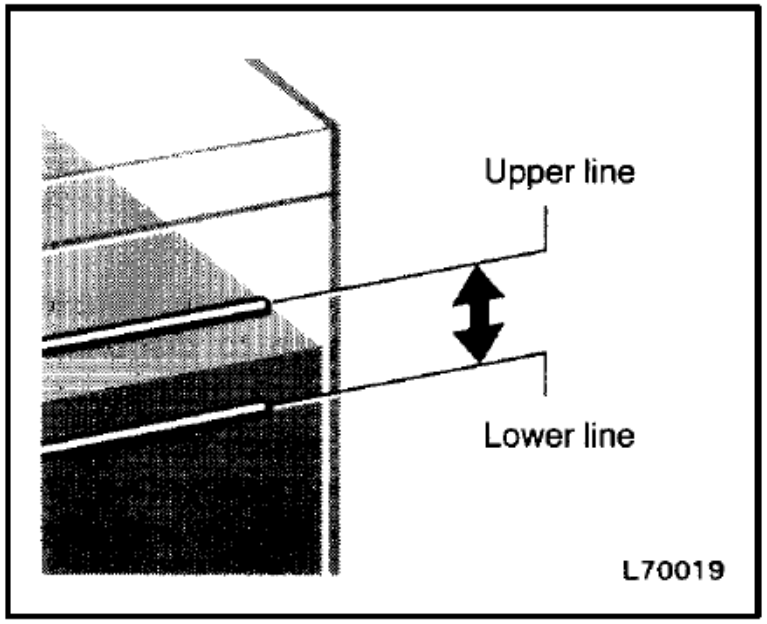
Non-maintenance battery

Hydrometer color		Condition
Type A	Type B	
GREEN	BLUE	Good
DARK	WHITE	Charging necessary. Have battery checked by your Toyota dealer.
CLEAR or LIGHT YELLOW	RED	Have battery checked by your Toyota dealer.

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

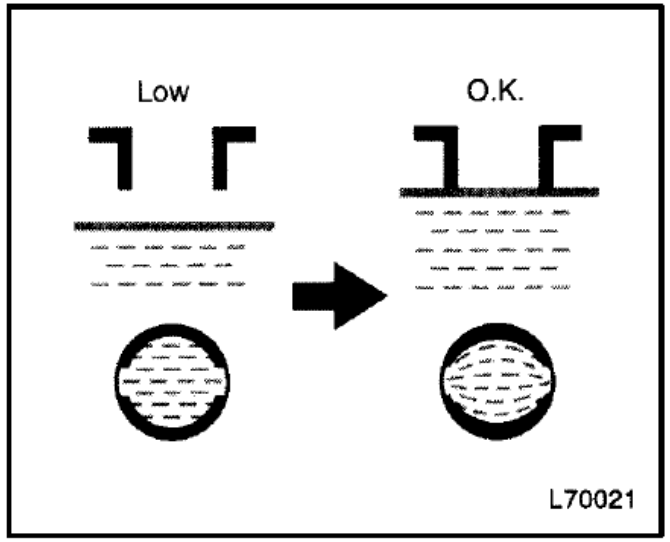
Battery Fluid and Terminals Example of Owner's Manual



CHECKING BY THE FLUID LEVEL LINES (MAINTENANCE TYPE BATTERY ONLY)

The fluid (electrolyte) level must be between the upper and lower lines.

When checking the fluid level, look at all six cells, not just one or two.



ADDING DISTILLED WATER (MAINTENANCE TYPE BATTERY ONLY)

1. Remove the vent plugs.
2. Add distilled water to cells needing fluid.

   If the side of your battery is covered, check the water level by looking down directly above the cell as illustrated above.
3. Retighten the vent plugs securely.

NOTICE

Do not overfill the cells. Excess electrolyte could squirt out of the battery during heavy charging, causing corrosion or damage.

NOTICE

Do not refill the battery with water.

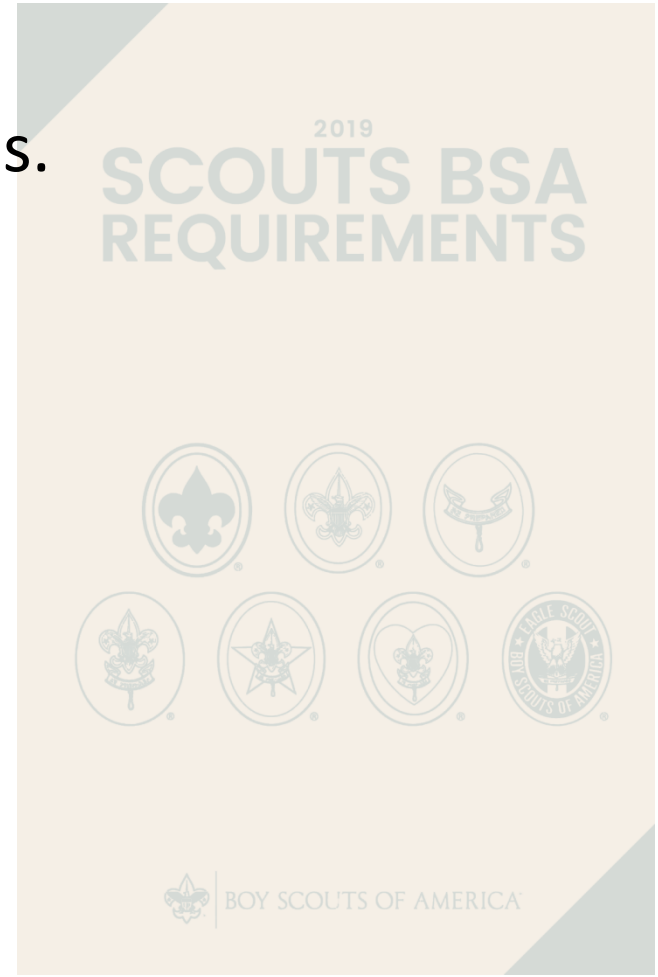
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Requirement 2c - Fuses

Locate the fuse boxes; determine the type and size of fuses.

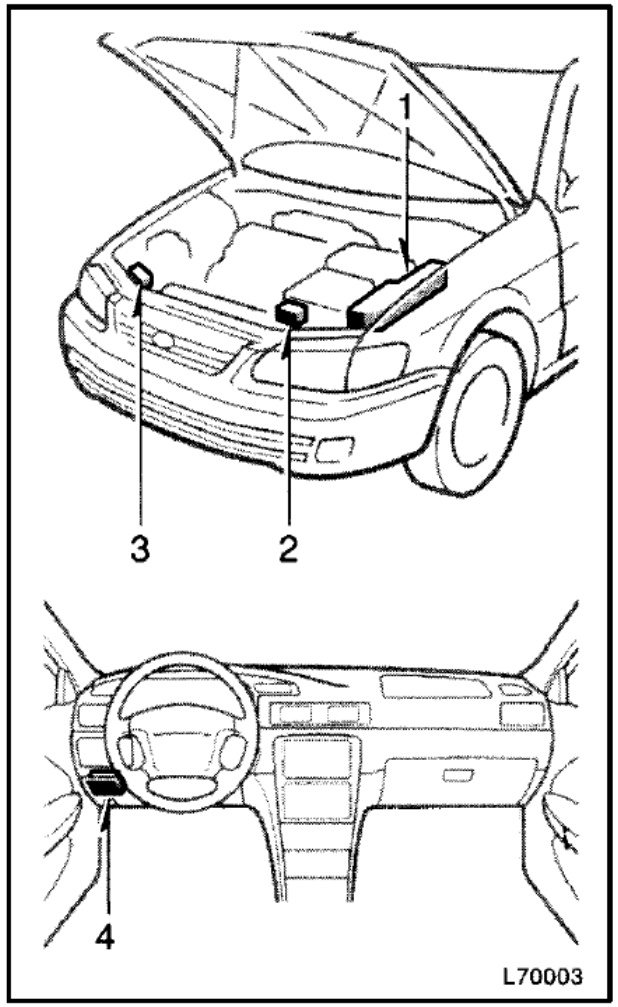
Demonstrate the proper replacement of burned-out fuses.

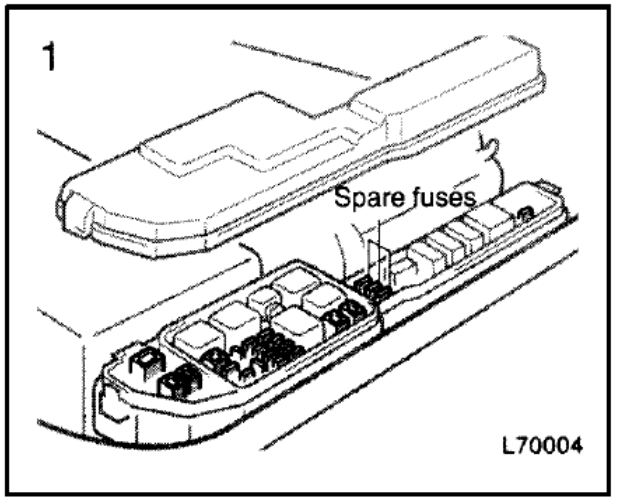


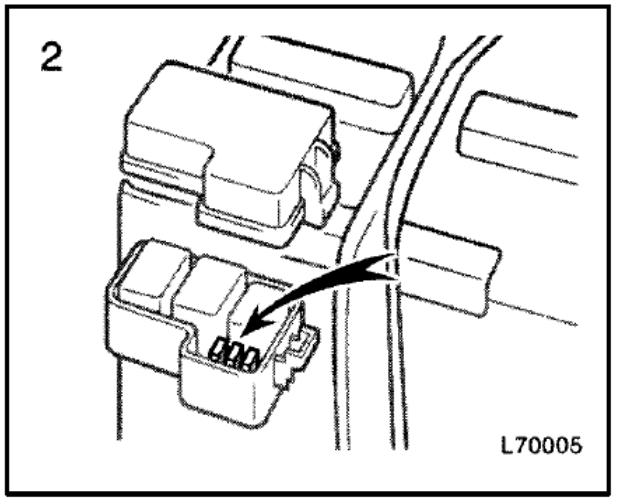
General Maintenance, Safety, and Registration

Fuses

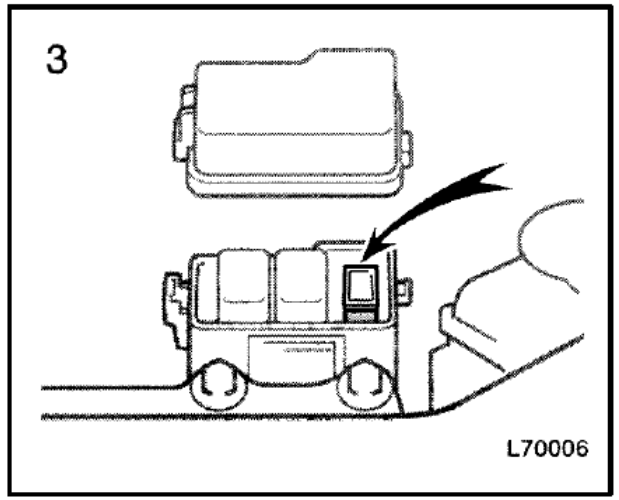
Example of Owner's Manual

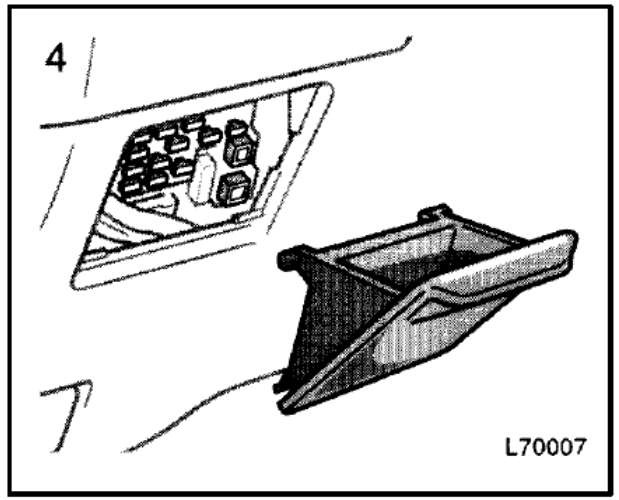






Canada only



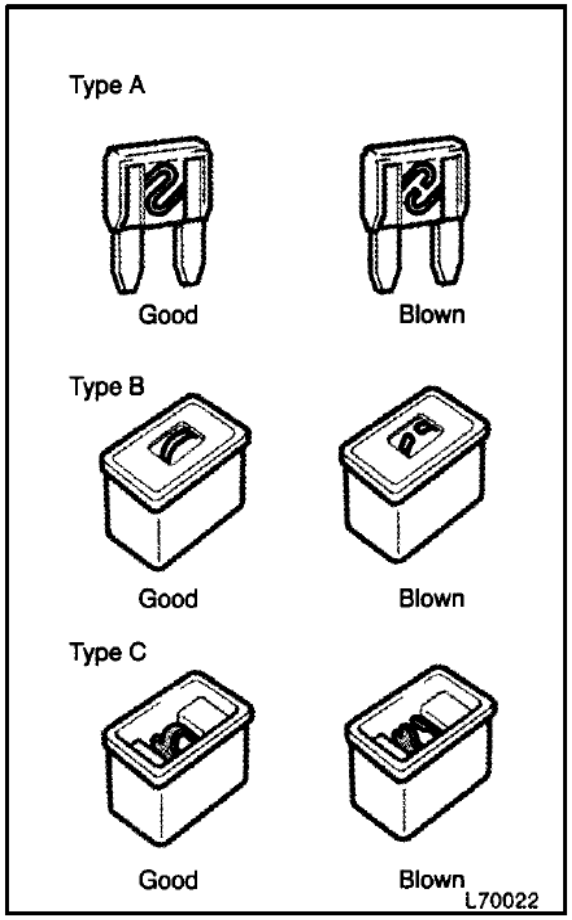


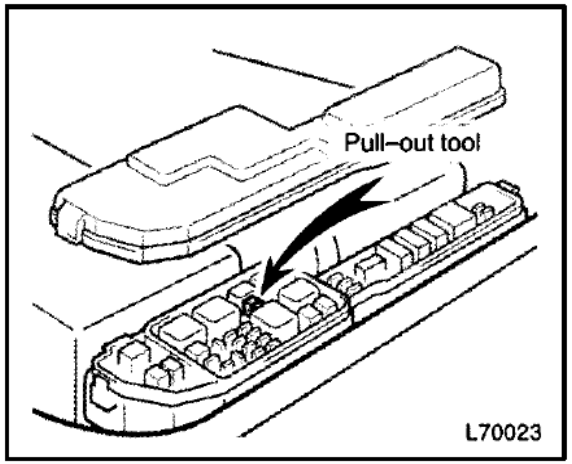
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Fuses

Checking and replacing fuses





If the headlights or other electrical components do not work, check the fuses. If any of the fuses are blown, they must be replaced.

See "Fuse locations" in Chapter 7-1 for locations of the fuses.

Turn the ignition switch and inoperative component off. Pull a suspected fuse straight out and check it.

Determine which fuse may be causing the problem. The lid of the fuse box shows the name of the circuit for each fuse. See Part 8 of this manual for the functions controlled by each circuit.

Example of Owner's Manual

Type A fuses can be pulled out by using the pull-out tool. The location of the pull-out tool is shown in the illustration.

If you are not sure whether the fuse has blown, try replacing the suspected fuse with one that you know is good.

If the fuse has blown, push a new fuse into the clip.

Only install a fuse with the amperage rating designated on the fuse box lid.

If you do not have a spare fuse, in an emergency you can pull out the "MIR HTR", "DOME" or "A/C" fuse, which may be dispensable for normal driving, and use it if its amperage rating is the same.

If you cannot use one of the same amperage, use one that is lower, but as close as possible to the rating. If the amperage is lower than that specified, the fuse might blow out again but this does not indicate anything wrong. Be sure to get the correct fuse as soon as possible and return the substitute to its original clip.

It is a good idea to purchase a set of spare fuses and keep them in your vehicle for emergencies.

If the new fuse immediately blows out, there is a problem with the electrical system. Have your Toyota dealer correct it as soon as possible.

⚠ CAUTION

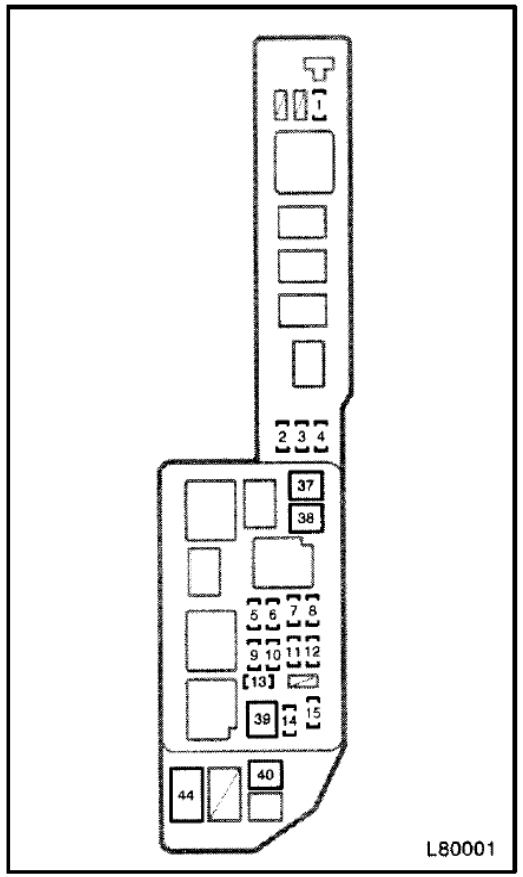
Never use a fuse with a higher amperage rating, or any other object, in place of a fuse. This may cause extensive damage and possibly a fire.

Images source: 2007 Toyota Camry Owner's Manual

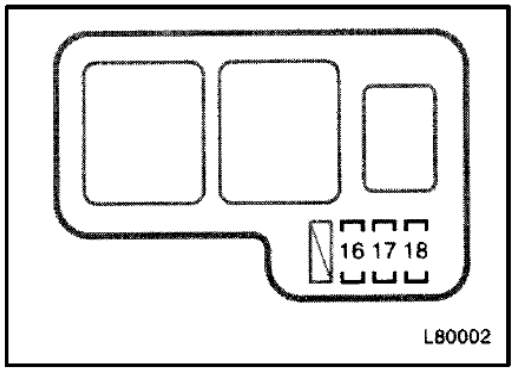
General Maintenance, Safety, and Registration

Fuses

Example of Owner's Manual



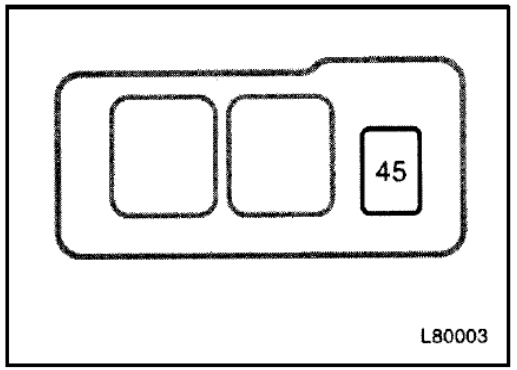
Engine compartment



Engine compartment (Canada)

Fuses (type A)

1. **A/C 10 A:** Air conditioning system
2. **10 A:** Spare fuse
3. **15 A:** Spare fuse
4. **30 A:** Spare fuse
5. **ALT-S 5 A:** Charging system
6. **HEAD (RH-HI) 15 A:** Right-hand headlight
7. **EFI 15 A:** Multiport fuel injection system/sequential multiport fuel injection system
8. **HORN 10 A:** Horn, theft deterrent system



Engine compartment

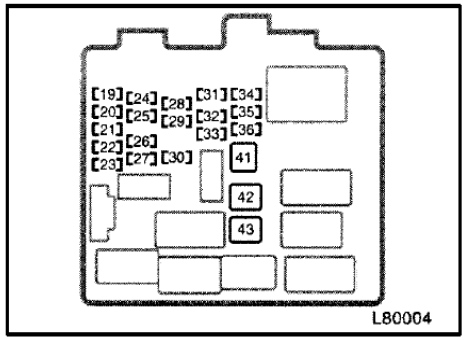
9. **HAZ 10 A:** Emergency flasher
10. **AM2 30 A:** Gauge and meter, SRS airbag system, Multiport fuel injection system/sequential multiport fuel injection system, "IGN" and "ST" fuses
11. **TEL 5 A:** No circuit
12. **HEAD (LH-HI) 15 A:** Left-hand headlight
13. **RAD NO.1 20 A:** Audio system

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Fuses

Example of Owner's Manual



Instrument panel

14. **DOME 7.5 A:** Theft deterrent system, daytime running light system, clock, locking with wireless remote control system, ignition switch light, personal light, trunk light, electric moon roof lamp, interior light, vanity mirror light, door courtesy light, power door lock system
15. **ECU-B 7.5 A:** Cruise control system, anti-lock brake system, SRS airbag system
16. **DRL NO. 2 5 A (vehicles sold in Canada):** Daytime running light system
17. **HEAD (LH-LO) 10 A:** Left-hand headlight
18. **HEAD (RH-LO) 10 A:** Right-hand headlight
19. **SEAT-HEATER 20 A:** No circuit
20. **HEATER 10 A:** Air conditioning system, rear window defogger, starting system
21. **GAUGE 10 A:** Gauges and meters, back-up lights, cruise control system, charging system, traction control system, daytime running light system, power windows, service reminder indicators and warning buzzers
22. **WIPER 20 A:** Windshield wipers and washer
23. **MIRROR-HEATER 10A:** Outside rear view mirror defogger
24. **ECU-IG 15 A:** Cruise control system, anti-lock brake system, power antenna, SRS airbag system, theft deterrent system, shift lock control system, traction control system, daytime running light system, locking with wireless remote control system, multiport fuel injection system/sequential multiport fuel injection system
25. **IGN 5A:** Gauges and meters, charging system, SRS airbag system, multiport fuel injection system/sequential multiport fuel injection system
26. **STOP 15 A:** Stop lights, cruise control system, high-mounted stoplight, anti-lock brake system, shift lock control system, multiport fuel injection system/sequential multiport fuel injection system
17. **TAIL 10 A:** Parking lights, license plate lights, tail lights, front side marker lights, daytime running light system, multiport fuel injection system/sequential multiport fuel injection system
28. **POWER-OUTLET 15 A:** Power outlet
29. **OBD 7.5 A:** On-board diagnosis system
30. **FOG 15 A:** No circuit
31. **STARTER 5 A:** Gauges and meters, multiport fuel injection system/sequential multiport fuel injection system
32. **DOOR 25 A:** Power door lock system, theft deterrent system, fuel filler door control system
33. **PANEL 7.5 A:** Gauge and meter, audio system, cigarette lighter, glove box light, clock, instrument panel light control, service reminder indicators, air conditioning control panel lights, ashtray light, emergency flasher, seat heater control system, daytime running light system, rear window defogger, electronically controlled automatic transmission system
34. **TURN 7.5 A:** Emergency flasher
35. **RAD-NO. 7 7.5 A:** Audio system, power
36. **CIG 15 A:** Cigarette lighter, shift lock control system, power rear view mirror controls, theft deterrent system, power door lock system, SRS airbag system, outside rear view mirror defogger, air conditioning system

Fuses (type B)

37. **CDS 30 A:** Electric cooling fans
38. **RADI FAN 30 A:** Electric cooling fans
39. **MAIN 40 A:** "HEAD (RH-HI)", "head (rh-lo)" FUSES
40. **HTR 50 A: "AM1", "A/C" fuses**
41. **DEF 40 A:** Rear window defogger
42. **PWR 30 A:** Power window control system, power seat, electric moon roof
43. **AM1 40 A:** Head lamp cleaner

Fuses (type C)

44. **ALT 100 A:** "RDI FAN", "CDS" fuses
45. **ABS 60 A:** Anti-lock brake system

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Requirement 2d – Belts and Hoses

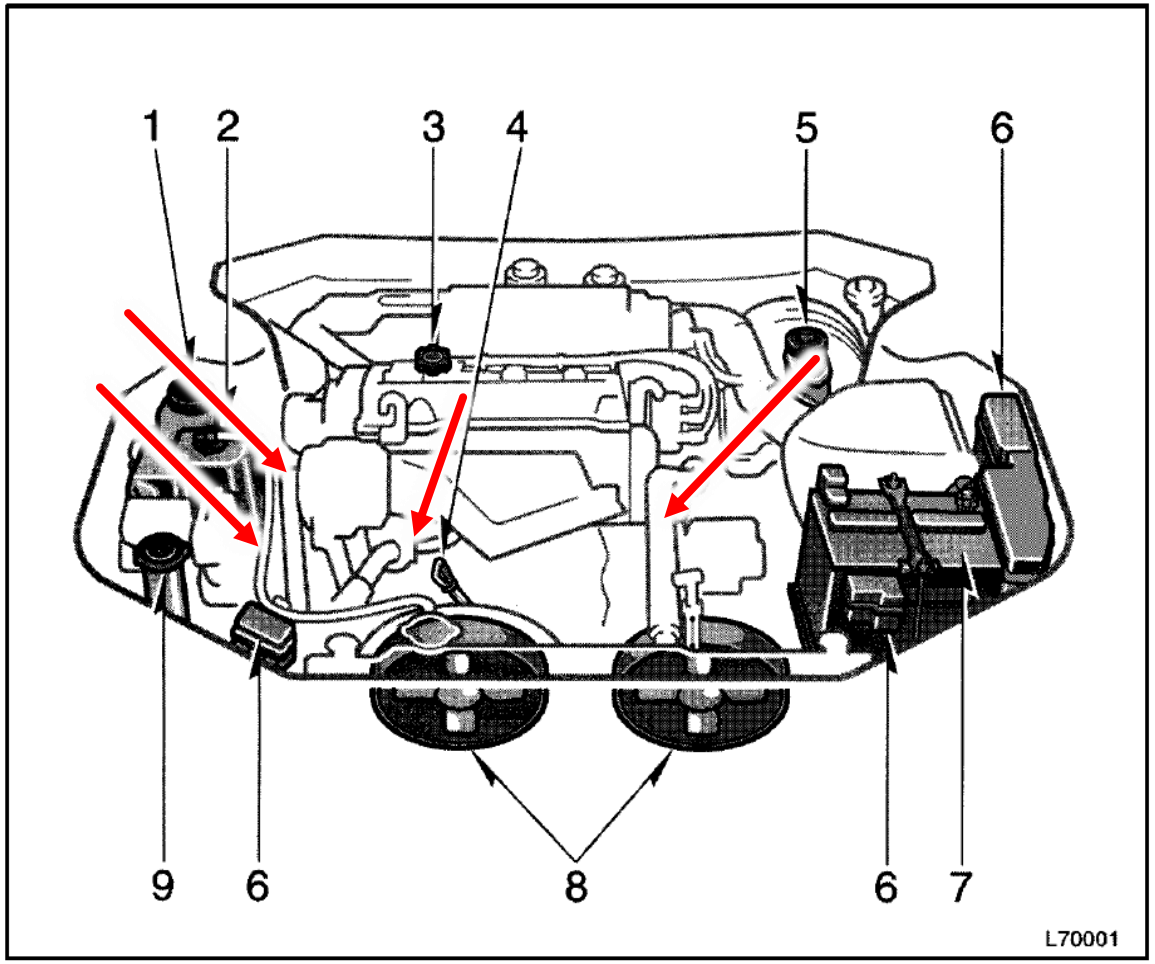
Demonstrate how to check the condition and tension of belts and hoses.

General Maintenance, Safety, and Registration

Belts and Hoses

Example of Owner's Manual

▶5S-FE engine



1. Power steering fluid reservoir
2. Engine coolant reservoir
3. Engine oil filler cap
4. Engine oil level dipstick
5. Brake fluid reservoir
6. Fuse blocks
7. Battery
8. Engine cooling fans
9. Windshield washer fluid tank

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Belts and Hoses

- Check hoses for
  - Leaks
  - Cracks
  - Loose clamps

General Maintenance, Safety, and Registration

Belts and Hoses

- Check belts for looseness
  - Ideally use a belt tension tool
    - These are very accurate
  - Many mechanics use the calibrated thumb
    - Often results in significant under tensioning of belt

Service specifications

ENGINE

Valve clearance (engine cold), mm (in.)

5S-FE engine

Intake	0.19—0.29	(0.007—0.011)
Exhaust	0.28—0.38	(0.011—0.015)

1MZ-FE engine

Intake	0.15—0.25	(0.006—0.010)
Exhaust	0.25—0.35	(0.010—0.014)

Spark plug type:

DENSO	PK20TR11
NGK	BKR6EKPB11

Spark plug gap, mm (in.):

1.1 (0.043)

Drive belt tension measured with Boroughs drive belt tension gauge No. BT-33-73F (used belt), lbf:

5S-FE engine

With air conditioning

Generator belt	130 ± 10
Power steering pump belt	80 ± 20

Without air conditioning

Generator belt	95 ± 20
Power steering pump belt	80 ± 20

1MZ-FE engine	115 ± 20

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Requirement 2e – Lights

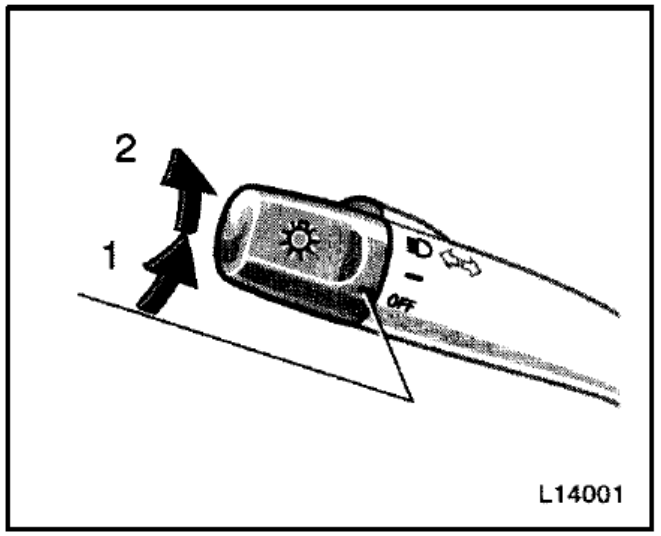
Check the vehicle for proper operation of its lights, including the interior overhead lights, instrument lights, warning lights, and exterior bulbs.

General Maintenance, Safety, and Registration

Lights

Example of Owner's Manual

Headlights and turn signals



HEADLIGHTS

To turn on the following lights: Twist the headlight/turn signal lever knob.

Position 1—Parking, tail, license plate, side marker and instrument panel lights

Position 2—Headlights and all of the above

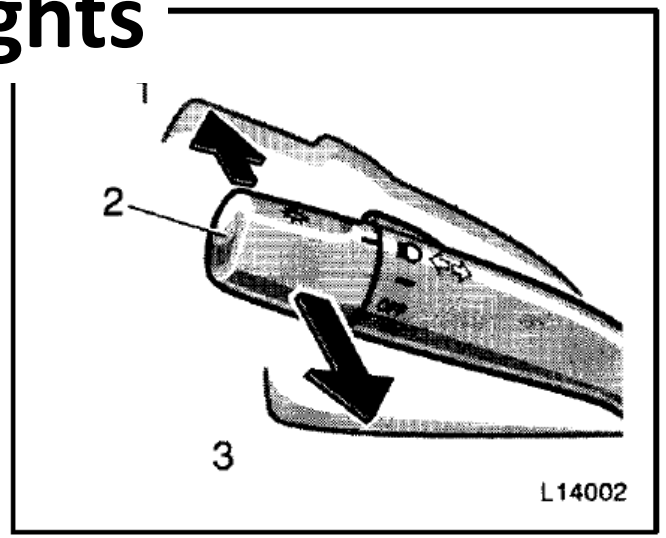
The lights automatically turn off when the driver's door is opened with the ignition turned off. To turn them on again, turn the key to the "ON" position or actuate the headlight switch. If you are going to park for over one week, make sure the headlight switch is off.

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Example of Owner's Manual

Lights

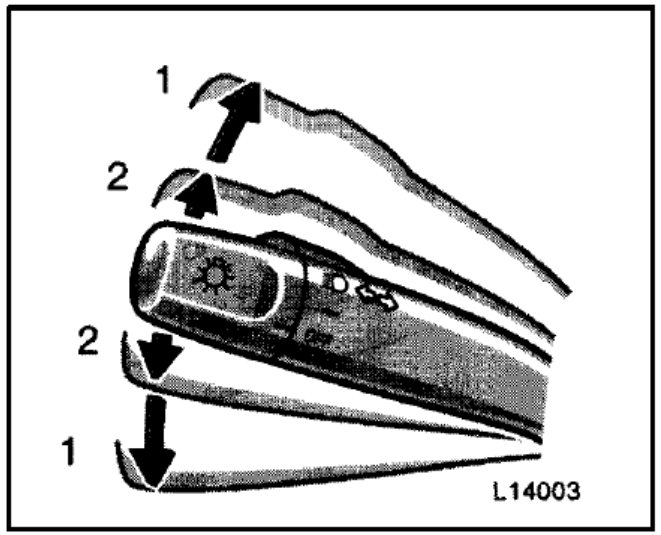


High-Low beams—For high beams, turn the headlights on and push the lever away from you (position 1). Pull the lever toward you (position 2) for low beams.

The headlight high beam indicator light (blue light) on the instrument panel will tell you that the high beams are on.

Flashing the high beam headlights (position 3)—Pull the lever all the way back. The high beam headlights turn off when you release the lever.

You can flash the high beam headlights with knob turned to "OFF".



TURN SIGNAL

To signal a turn, push the headlight/ turn signal lever up or down to position 1.

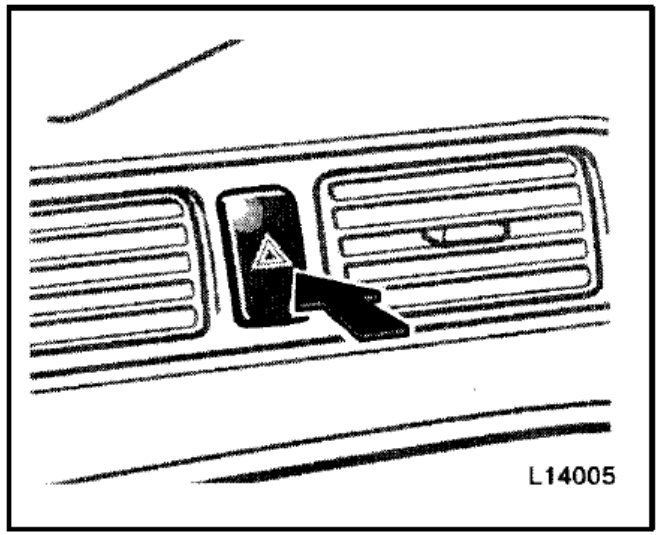
The key must be in the "ON" position.

The lever automatically returns after you make a turn, but you may have to return it by hand after you change lanes.

To signal a lane change, move the lever up or down to the pressure point (position 2) and hold it.

If the turn signal indicator lights (green lights) on the instrument panel flash faster than normal, a front or rear turn signal bulb is burned out.

Emergency flashers



To turn on the emergency flashers, push the switch.

All the turn signal lights will flash. To turn them off, push the switch once again.

Turn on the emergency flashers to warn other drivers if your vehicle must be stopped where it might be a traffic hazard.

Always pull as far off the road as possible.

The turn signal light switch will not work when the emergency flashers are operating.

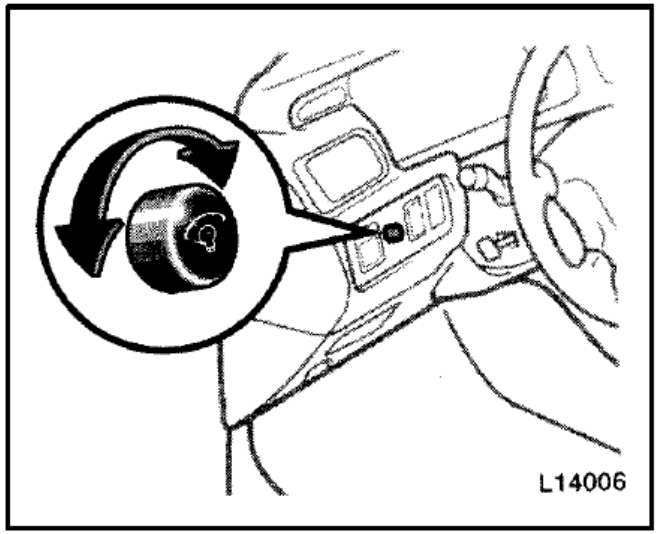
Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Example of Owner's Manual

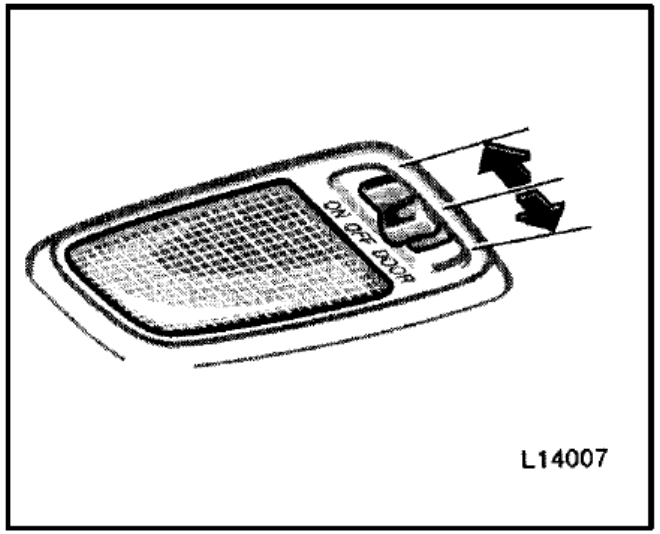
Lights

Instrument panel light control



To adjust the brightness of the instrument panel lights, turn the knob.

Interior light



To turn on the interior light, slide the switch.

The interior light has the following position:

"ON"—Keeps the light on all the time.

"OFF"—Turns the light off.

"DOOR"—Turns the light on when any of the door is opened. The light goes off when all the doors are closed. On some models, the light remains on for some time after all of the doors are closed.

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Requirement 2f – Air Filters

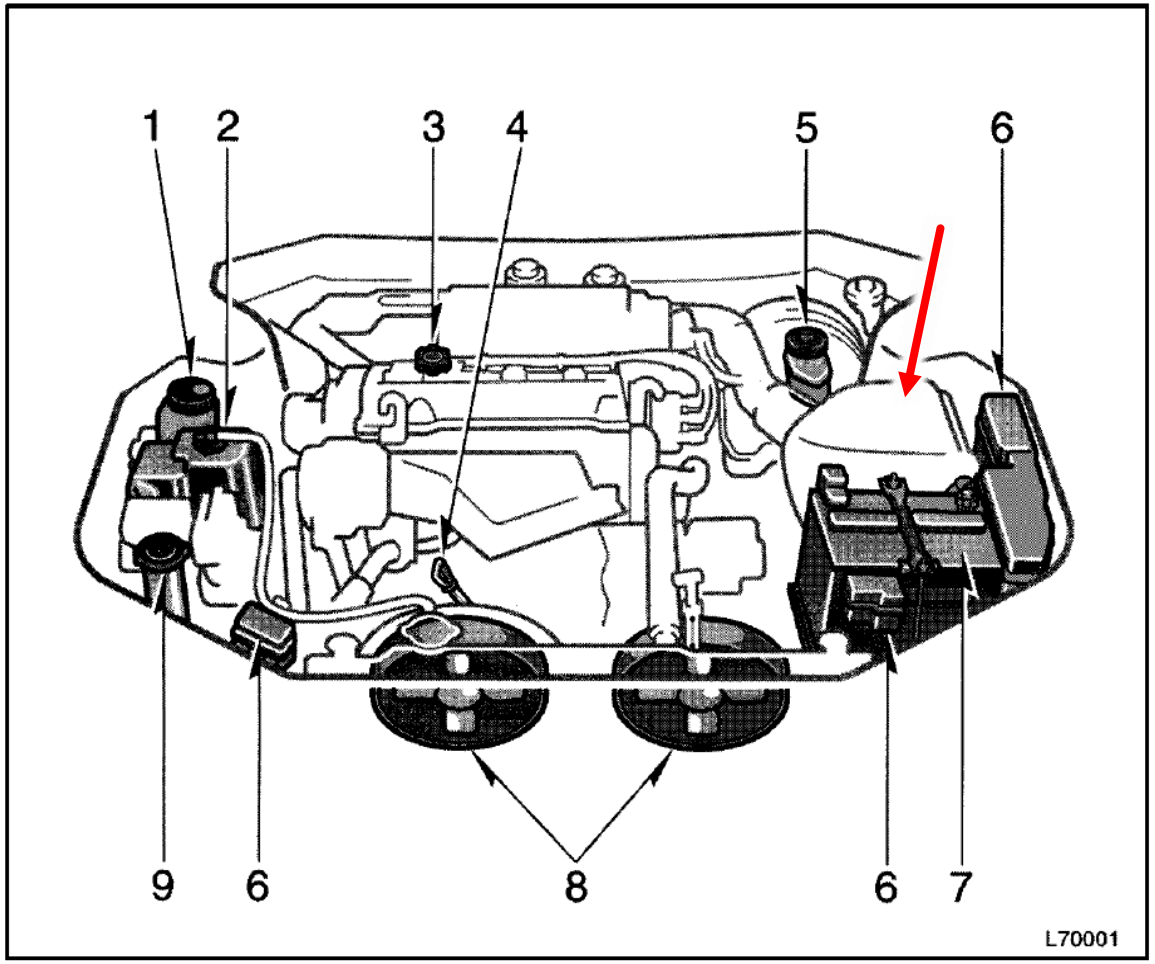
Locate and check the air filter(s).

General Maintenance, Safety, and Registration

Air Filter

Example of Owner's Manual

▶5S-FE engine



1. Power steering fluid reservoir
2. Engine coolant reservoir
3. Engine oil filler cap
4. Engine oil level dipstick
5. Brake fluid reservoir
6. Fuse blocks
7. Battery
8. Engine cooling fans
9. Windshield washer fluid tank

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Air Filter

- Air filter maintenance may or may-not be found in the owner's manual
- If not in owner's manual – check repair manual
  - Usually located in collector box by fender

- To inspect filter
  - Remove it from collector box
  - Hold up to sun or bright light
  - If you can't see through it, tap it on hard surface to shake out dirt
  - If you still can't see through it, it's time to replace it

Images Source: 1997 Toyota Camry Owner's Manual

General Maintenance, Safety, and Registration

Requirement 2g – Safety

Explain the purpose, importance, and limitations of safety belts and passive restraints.

General Maintenance, Safety, and Registration

Safety

- Seat belts
  - Best defense against impaired, aggressive, and distracted drivers

- Buckling up helps keep you safe & secure inside your vehicle in a crash
  - Being completely ejected from a vehicle is almost always deadly

- Air bags are designed to work with seat belts, not replace them
  - If you don’t wear your seat belt, you could be thrown into a rapidly opening frontal air bag – This can injure or even kill you

www.nhtsa.gov/risky-driving/seat-belts

General Maintenance, Safety, and Registration

Requirement 2h – Emissions and Safety Inspections

Find out the requirements for your state's emissions and safety inspections (as applicable), including how often a vehicle needs to be inspected.

General Maintenance, Safety, and Registration

Emissions and Safety Inspections

Washington State:

After 38 years, Washington's emission check program ended Jan. 1, 2020. With the end of the program, vehicle owners are no longer required to have their vehicle's emissions tested before renewing their registration.

ecology.wa.gov/Air-Climate/Air-quality/Vehicle-emissions/Emissions-check-ends

General Maintenance, Safety, and Registration

Requirement 2i – Registering a Vehicle

Explain the importance of registering a vehicle and find out the annual registration fee for renewing your family car's registration.

General Maintenance, Safety, and Registration

Registering a Vehicle

- Purpose - establish a link between a vehicle and an owner or user
- Link used for
  - Taxation
  - Crime detection purposes

General Maintenance, Safety, and Registration

Registering a Vehicle – Registration Fee

- For Washington State – See: www.dol.wa.gov/vehicleregistration/fees.html

Dashboard

Dashboard

Requirement 3a – Dashboard Gauges

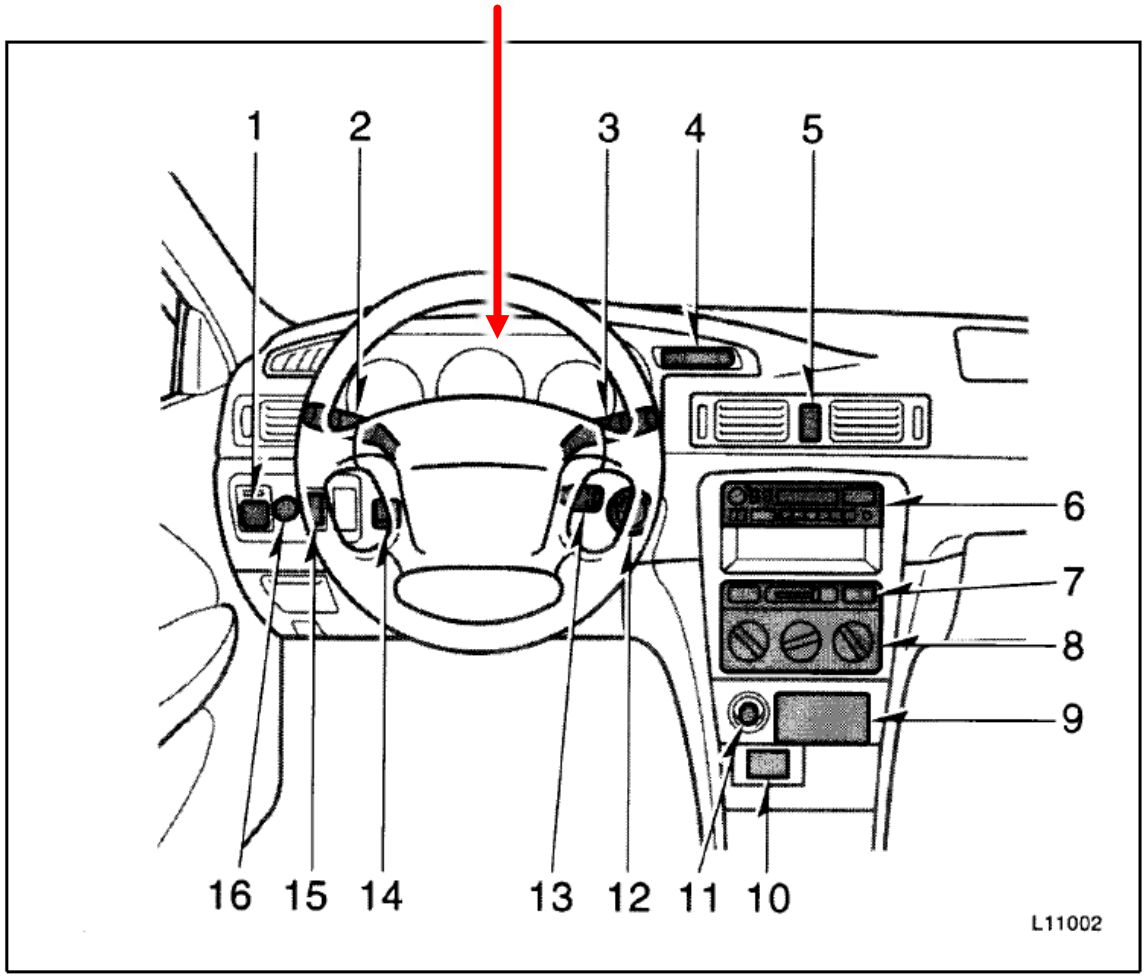
Explain the function of the fuel gauge, speedometer, tachometer, oil pressure, and engine temperature gauge.

Point out each one on the instrument cluster.

Dashboard

Dashboard Gauges

Example of Owner's Manual



1. Power rear view mirror control switch
2. Headlight and turn signal switch
3. Wiper and washer switches
4. Clock
5. Emergency flasher switch
6. Car audio
7. Rear window and outside rear view mirror defoggers switch
8. Air conditioning controls
9. Front ashtray
10. Power outlet
11. Cigarette lighter
12. Ignition switch
13. Cruise control switch
14. Tilt steering lock release lever
15. Traction control system off switch
16. Instrument panel light control knob

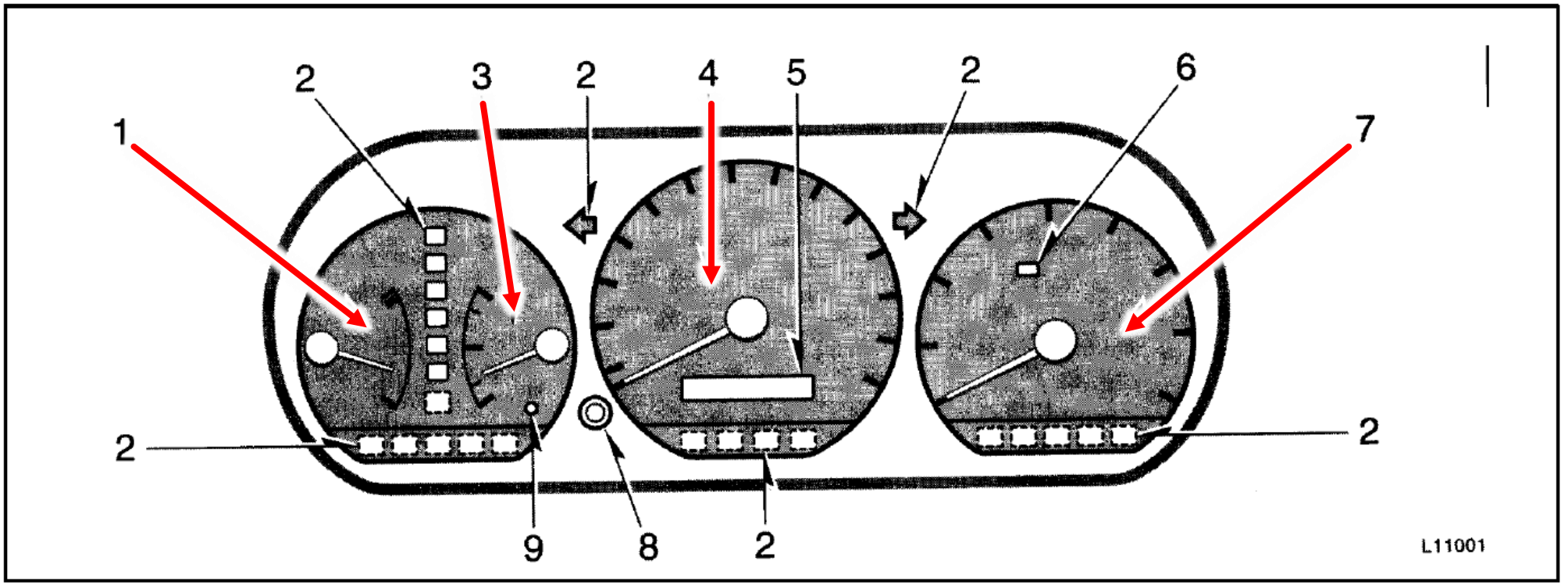
Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

Dashboard Gauges

Example of Owner's Manual

Instrument cluster overview



1. Engine coolant temperature gauge
2. Service reminder indicators or indicator lights
3. Fuel gauge
4. Speedometer
5. Odometer and two trip meters
6. Theft deterrent system indicator light
7. Tachometer
8. Trip meter reset knob
9. Low fuel level warning light

Images Source: 1997 Toyota Camry Owner's Manual

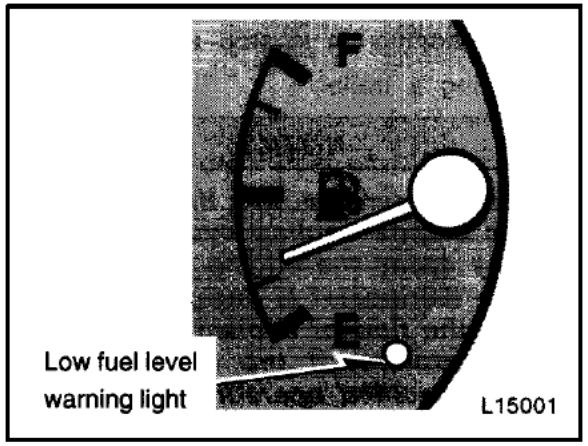
Dashboard

Dashboard Gauges

Fuel Gauge:
How much fuel is in tank

Example of Owner's Manual

Fuel gauge



The gauge works when the ignition switch is on and indicates the approximate quantity of fuel remaining in the tank.

Nearly full—Needle at "F"

Nearly empty—Needle at "E"

It is a good idea to keep the tank over 1/4 full.

This fuel gauge has a non-return type needle which remains at the last indicated position when the ignition switch is turned off.

If the level approaches "E" or the low fuel level warning light comes on, fill the fuel tank as soon as possible.

If the fuel tank is completely empty, the malfunction indicator lamp comes on. Fill the fuel tank immediately.

The indicator lamp goes off after driving several times. If the indicator lamp does not go off, contact your Toyota dealer as soon as possible.

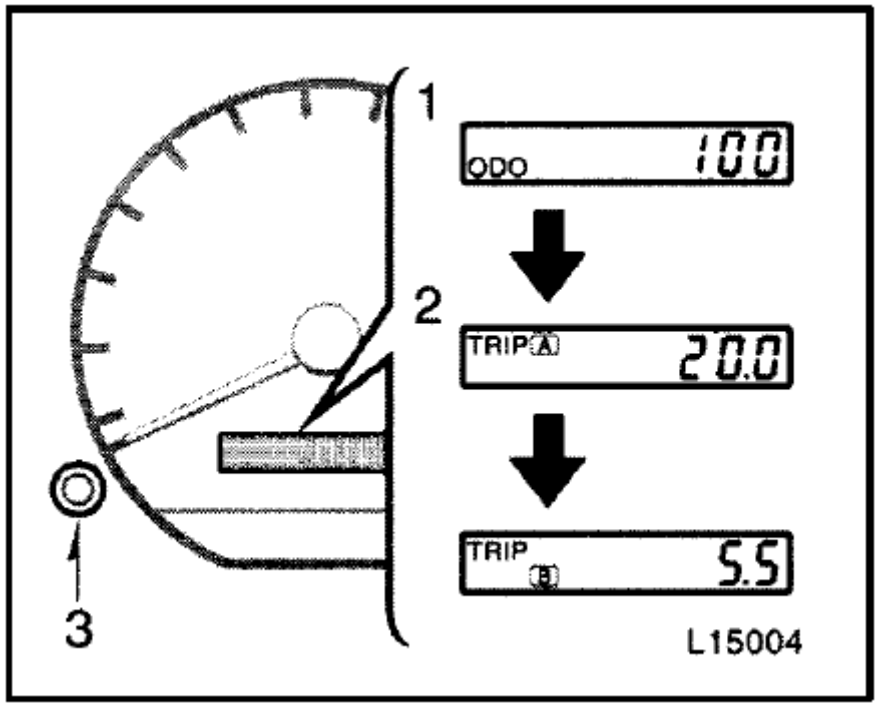
Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

Dashboard Gauges

Example of Owner’s Manual

Speedometer:
Speed of car



Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

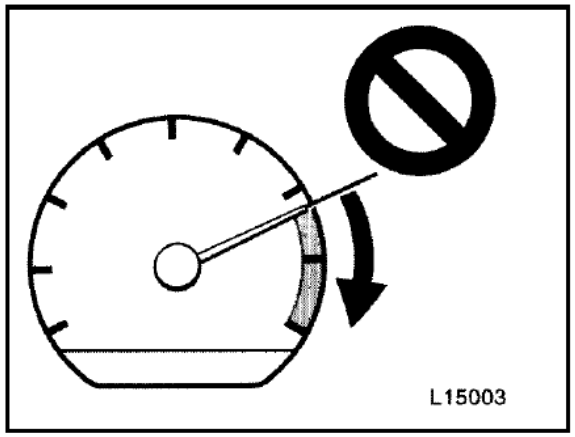
Dashboard Gauges

Tachometer:
RPM of engine

Some vehicle don’t have this guage

Example of Owner’s Manual

Tachometer



The tachometer indicates engine speed in thousands of rpm (revolutions per minute). Use it while driving to select correct shift points and to prevent engine lugging and overrevving.

Driving with the engine running too fast causes excessive engine wear and poor fuel economy. Remember, in most cases the slower the engine speed, the greater the fuel economy.

NOTICE

Do not let the indicator needle get into the red zone. This may cause severe engine damage.

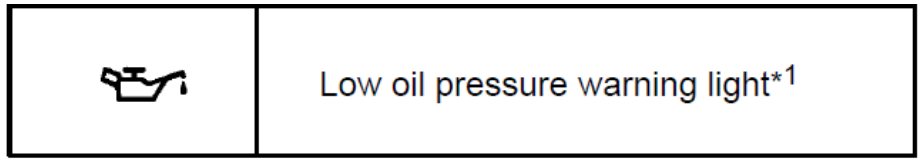
Images Source: [1997 Toyota Camry Owner's Manual]

Dashboard

Dashboard Gauges

Example of Owner’s Manual

Engine Oil Pressure:
Pressure of engine oil
Many cars don’t have a gauge and just have a warning light



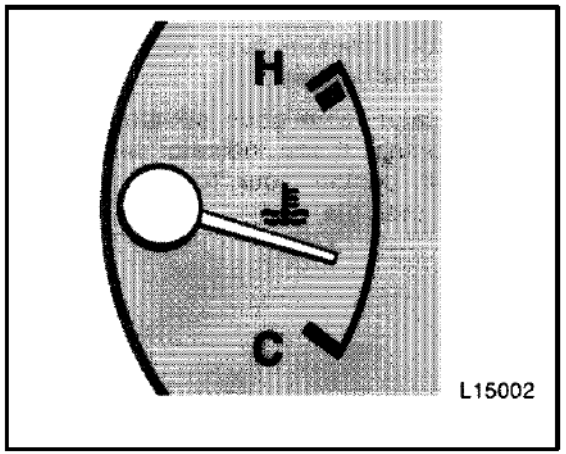
Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

Dashboard Gauges

Engine Temperature:
Operating temperature of coolant

Engine coolant temperature gauge



The gauge indicates the engine coolant temperature when the ignition switch is on. The engine operating temperature will vary with changes in weather and engine load.

If the needle moves into the red zone, your engine is too hot. If your vehicle overheats, stop your vehicle and allow the engine to cool.

Your vehicle may overheat during severe operating conditions, such as:

- Driving up a long hill on a hot day.
- Reducing speed or stopping after high speed driving.
- Idling for a long period with the air conditioning on in stop-and-go traffic.
- Towing a trailer

NOTICE

- ***Do not remove the thermostat in the engine cooling system as this may cause the engine to overheat. The thermostat is designed to control the flow of coolant to keep the temperature of the engine within the specified operating range.***
- ***Do not continue driving with an overheated engine. See "If your vehicle overheats" in Part 4.***

Example of Owner's Manual

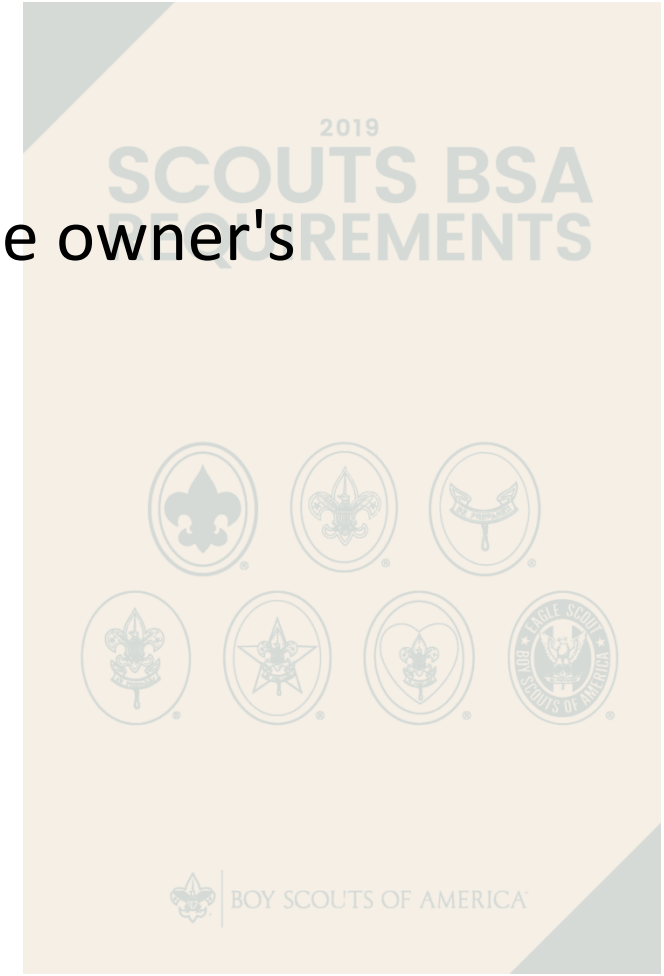
mages Source: [1997 Toyota Camry Owner's Manual]

Dashboard

Requirement 3b – Dashboard Symbols

Explain the symbols that light up on the dashboard and the difference between the yellow and red symbols.

Explain each of the indicators on the dashboard, using the owner's manual, if necessary.



Dashboard

Dashboard Symbols

- A Red warning light always demands immediate attention
  - Engine temperature
  - Oil pressure
  - Brake warning light

- Red indicator usually means
  - Stop as soon as you are able to safely stop
  - Tow truck time

Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

Dashboard Symbols

- A Yellow warning light are also important
  - “Check Engine”
  - “SRS” (Supplemental Restraint System aka “air bags”)
  - ABS (Anti-Lock Braking System)

- Yellow indicator usually means
  - Something is wrong
  - An SRS or ABS light usually means those safety features don’t work
  - Check Engine light can mean many things

Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

Dashboard Symbols

Example of Owner's Manual

Indicator symbols on the instrument panel

BRAKE (type A)  (type B)	Brake system warning light *1
	Seat belt reminder light*1
	Discharge warning light*1
 CHECK	Malfunction indicator lamp*1
	Low oil pressure warning light*1

ABS (type A)  (type B)	Anti-lock brake system warning light *1
	Open door warning light*1
	Rear light failure warning light*1
	SRS airbag warning light*1
	Low windshield washer fluid warning light*1

Images Source: 1997 Toyota Camry Owner's Manual

Dashboard

Dashboard Symbols

TRAC OFF	Traction control system off indicator/warning light *1
	Turn signal indicator lights.
	Headlight high beam indicator light
O/D OFF	Overdrive-of f indicator lighrt.
CRUISE	Cruise control indicator light*2

Example of Owner's Manual

P R N D 2 L	Automatic transmission indicator light.
	Slip indicator light.

*1: For details, see "Service reminder indicators and warning buzzers" in Chapter 1-5.
*2: If this light flashes, see "Cruise control" in Chapter 1-6.

Images Source: 1997 Toyota Camry Owner's Manual

Tires

Tires

Requirement 4a – Tire Specifications

Explain the difference between tire manufacturer's and vehicle manufacturer's specifications and show where to find them.

Tires

Tire Specifications

- PSI value listed on the tire wall is the maximum safe pressure
  - Max pressure to safely support its maximum load rating

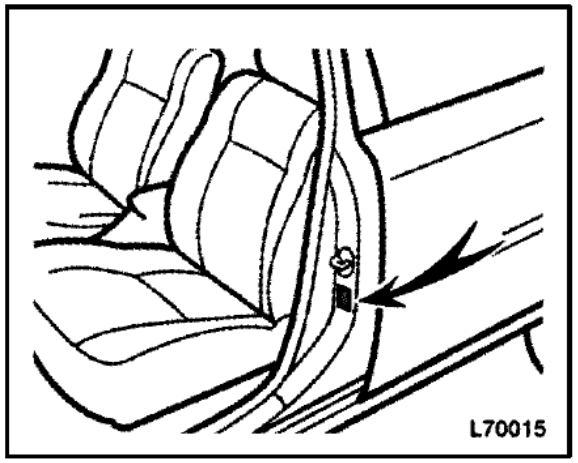
- Vehicles vary in how they distribute their weight
  - Vehicle manufacture's pressure specific to that vehicle
    - Best fuel economy
    - Best tire wear
    - Best tire performance

Tires

Tire Specifications

Example of Owner's Manual

Checking tire pressure



Keep your tire pressures at the proper level.

The recommended cold tire pressures, tire size and the vehicle capacity weight are also given in Part 8. They are also on the tire pressure label shown.

You should check the tire pressures every two weeks, or at least once a month. And don't forget the spare!

Incorrect tire pressure can reduce tire life and make your vehicle less safe to drive.

Low tire pressure results in excessive wear, poor handling, reduced fuel economy, and the possibility of blowouts from overheated tires. Also, low tire pressure can cause poor sealing of the tread bead. If the tire pressure is excessively low, there is the possibility of wheel deformation and/or tire separation.

High tire pressure produces a harsh ride, handling problems, excessive wear at the center of the tire tread, and a greater possibility of tire damage from road hazards.

If a tire frequently needs refilling, have it checked by your Toyota dealer.

Tires

Tire Specifications

Example of Owner's Manual

TIRES

- Ensure that your vehicle's tires are properly inflated. Adjust the tire pressure to the recommended cold tire pressure indicated below (see Chapter 7-2 for instructions.):

Tire pressure, kPa (kgf/cm^2 or bar, psi)

5S-FE engine

Front 210 (2.1, 30)

Rear 210 (2.1, 30)

1MZ-FE engine

Front 220 (2.2, 32)

Rear 220 (2.2, 32).

- The trailer tires should be inflated to the pressure recommended by the trailer manufacturer in respect to the total trailer weight.

Tires

Requirement 4b – Tire Pressure Check

Demonstrate how to check pressure and properly inflate a tire.

Check the spare tire and make sure it is ready for use.

Tires

Tire Pressure Check

Example of Owner's Manual

The following instructions for checking tire pressure should be observed:

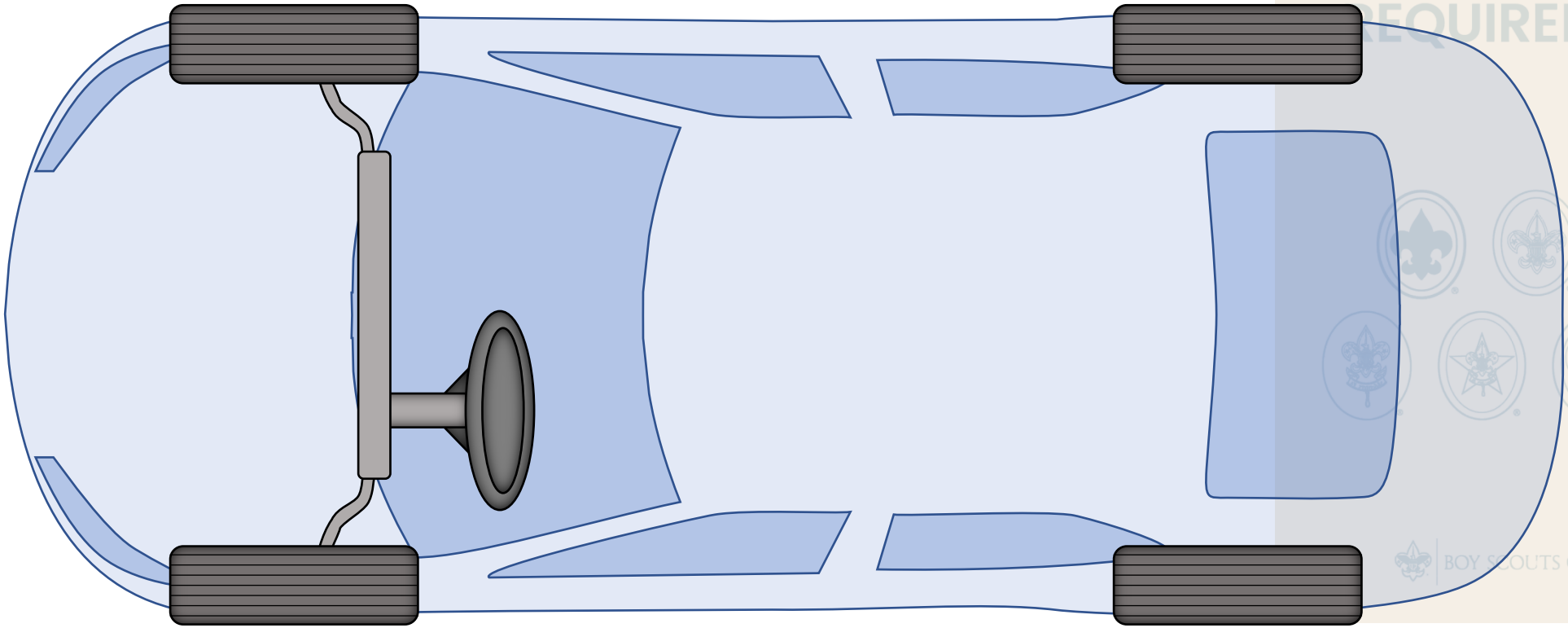
- **The pressure should be checked only when the tires are cold.** If your vehicle has been parked for at least 3 hours and has not been driven for more than 1.5 km or 1 mile since, you will get an accurate cold tire pressure reading.
- **Always use a tire pressure gauge.** The appearance of a tire can be misleading. Besides, tire pressure that are even just a few pounds off can degrade handling and ride.
- **Take special care when adding air to the compact spare tire.** The smaller tire size can gain pressure very quickly. Add compressed air in small quantities and check the pressure often until it reaches the specified pressure.
- **Do not bleed or reduce tire pressure after driving.** It is normal for the tire pressure to be higher after driving.
- **Never exceed the vehicle capacity weight.** The passenger and luggage weight should be located so that the vehicle is balanced.
- **Be sure to reinstall the tire inflation valve caps.** Without the valve caps, dirt or moisture could get into the valve core and cause air leakage. If the caps have been lost, have new ones put on as soon as possible.

Tires

Requirement 4c – Wheel Alignment

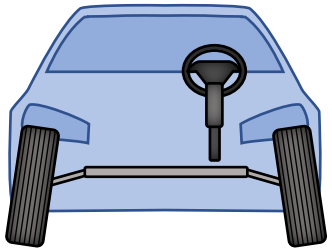
Explain why wheel alignment is important to the life of a tire.

Explain camber, caster, and toe-in adjustments on wheel alignment.

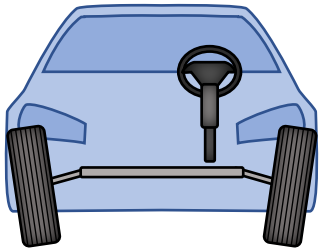


Tires

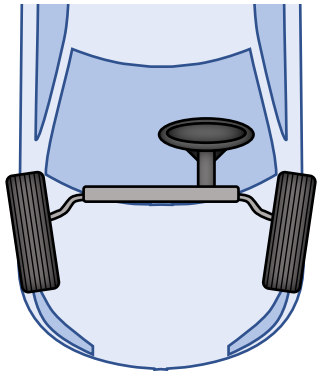
Wheel Alignment



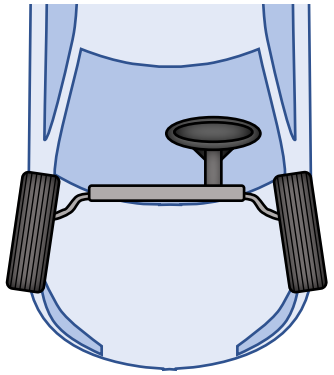
Negative Camber



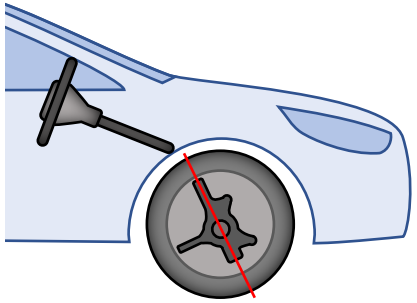
Positive Camber



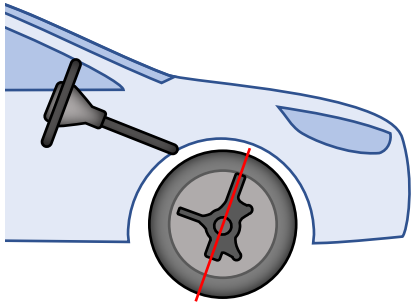
Toe In



Toe Out



Positive Caster



Negative Caster

Want more? See: https://www.youtube.com/watch?v=7d2K_mKgsZ0

Tires

Wheel Alignment

- Proper wheel alignment lines up the tires of a car
  - Maximizes handling and performance
  - Maximizes tire wear
- Improper alignment leads to
  - Poor or even dangerous handling
  - Excessive wear of tire

Tires

Requirement 4d – Lateral-Wear Bar Indicator

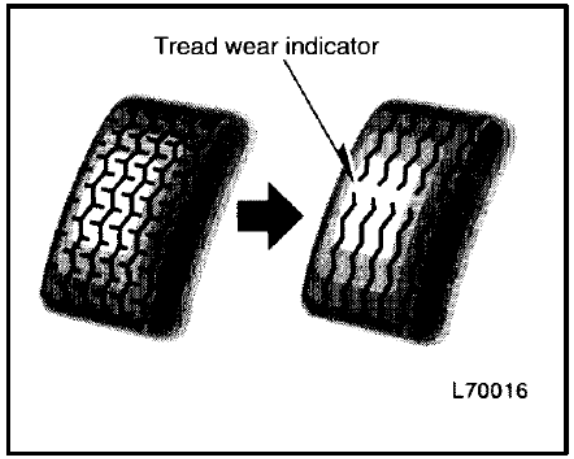
Explain the purpose of the lateral-wear bar indicator.

Tires

Lateral-Wear Bar Indicator

Example of Owner's Manual

Checking and replacing tires



CHECKING YOUR TIRES

Check the tire tread for the tread wear indicators. If the indicators show, replace the tires.

The tires on your Toyota have built-in tread wear indicators to help you know when the tires need replacement. When the tread depth wears to 1.6 mm (0.06 in.) or less, the indicators will appear. If you can see the indicators in two or more adjacent grooves, the tire should be replaced. The lower the tread, the higher the risk of skidding.

The effectiveness of snow tires is lost if the tread wears down below 4 mm (0.16 in.).

Tires

Lateral-Wear Bar Indicator

- Tire wear indicator bar provides a visual indication of tire wear
- If bar is flush with rest of tread
  - Tires is worn to 2/32”
  - Tire should be replaced

Tires

Requirement 4e – Tire Disposal

Explain how to dispose of old tires in accordance with local laws and regulations.

Tires

Tire Disposal

- Washington State:
  - Leave your old tires at the tire store when you buy new ones.
  - Ask your local transfer station if they accept tires.
  - Call 1-800-RECYCLE
  - Visit 1800recycle.wa.gov to find a disposal location in your area

ecology.wa.gov/Waste-Toxics/Business-waste/Manage-your-waste/Waste-tires

Engine

Engine

Requirement 5a – Internal Combustion Engine

Explain how an internal combustion engine operates.

Tell the differences between gasoline and diesel engines.

Explain how a gasoline-electric hybrid vehicle is powered.

Engine

Internal Combustion Engine

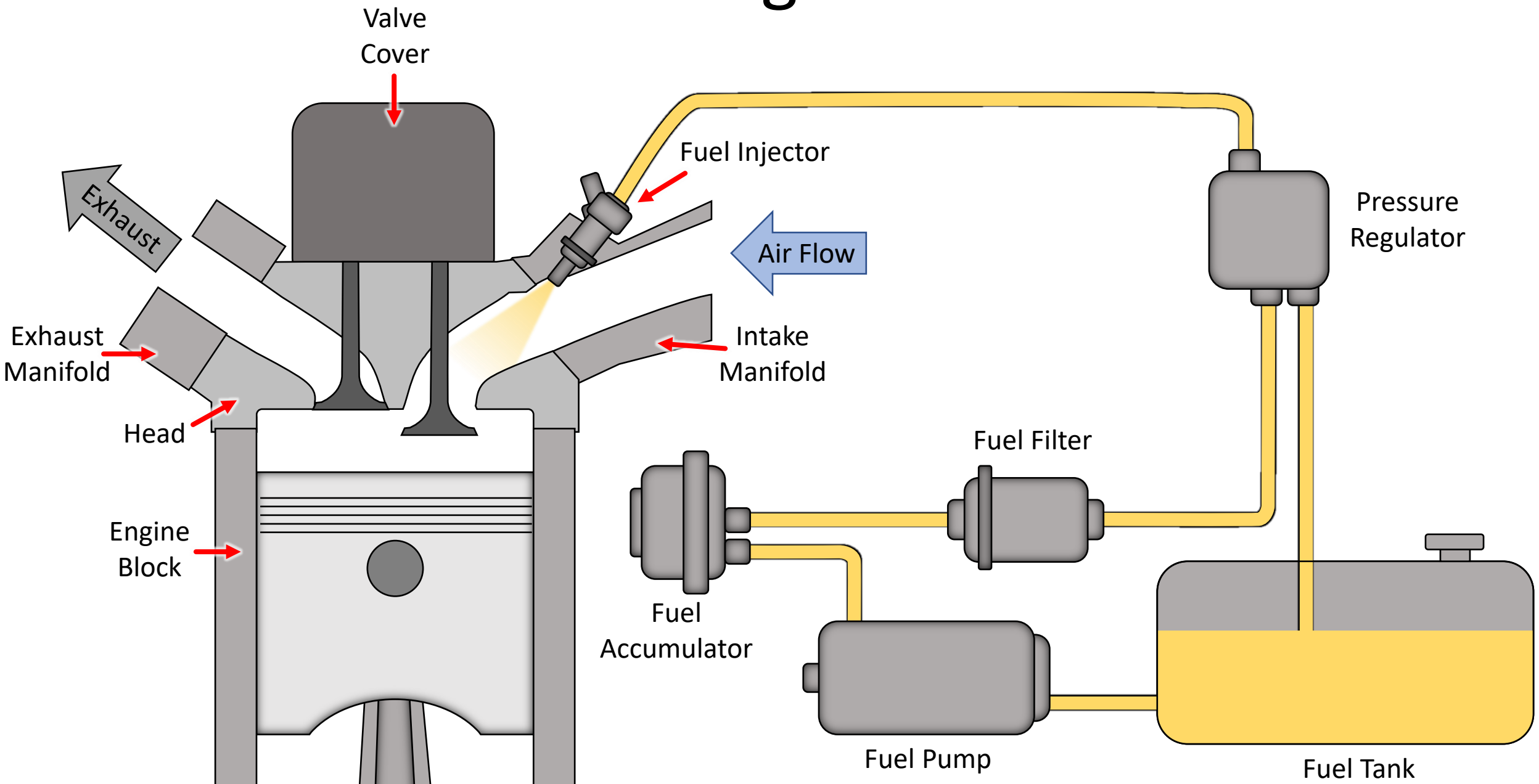
youtube.com/watch?v=ZQvfHyfgBtA

Engine

Internal Combustion Engine – Gas vs Diesel

youtube.com/watch?v=rXVJG9n6BAs

Engine


Valve Cover
Fuel Injector
Exhaust
Air Flow
Pressure Regulator
Exhaust Manifold
Intake Manifold
Head
Fuel Filter
Engine Block
Fuel Accumulator
Fuel Pump
Fuel Tank

Engine

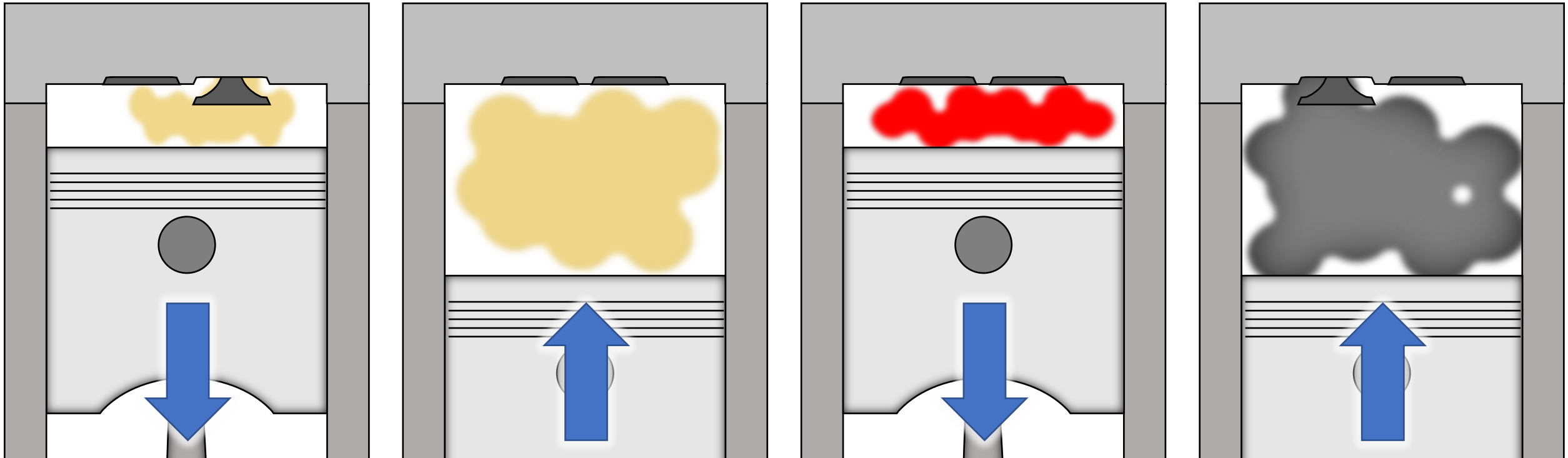
4-Stroke Action

Induction Stroke
Fuel and Air
Enters Chamber

Compression Stroke
Fuel and Air
Compresses

Power Stroke
Compressed
Air and Fuel Ignite

Exhaust Stroke
Burned Gasses
Exits Chamber

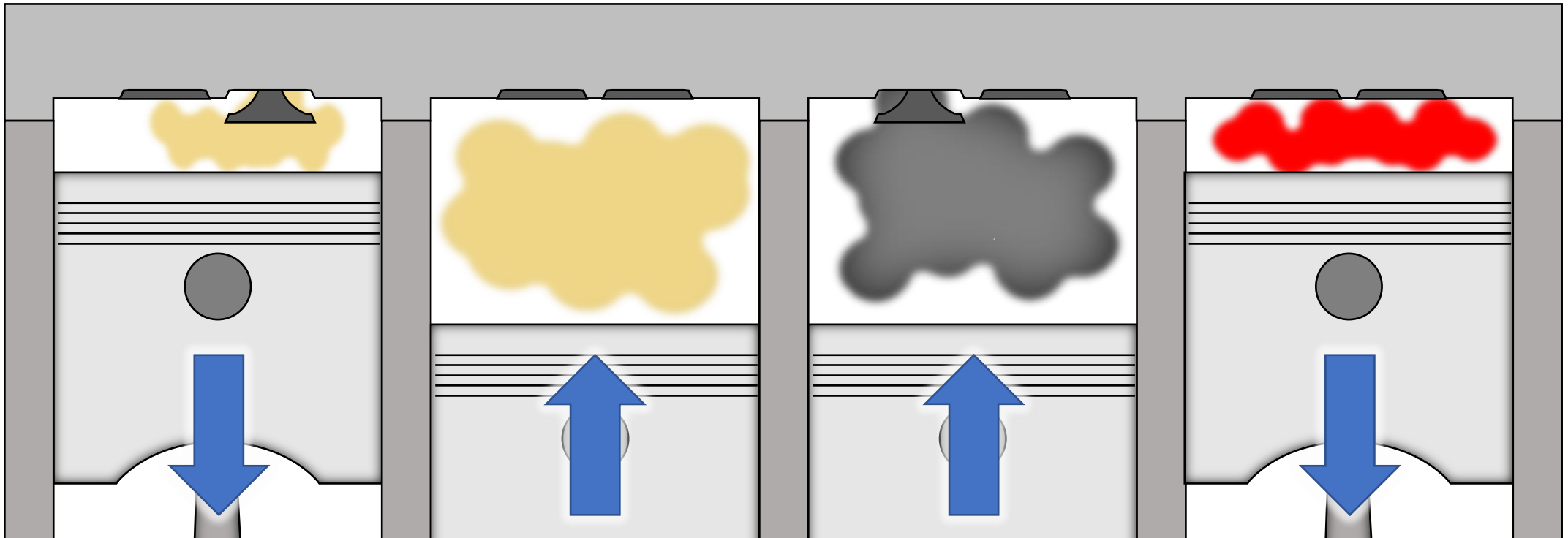


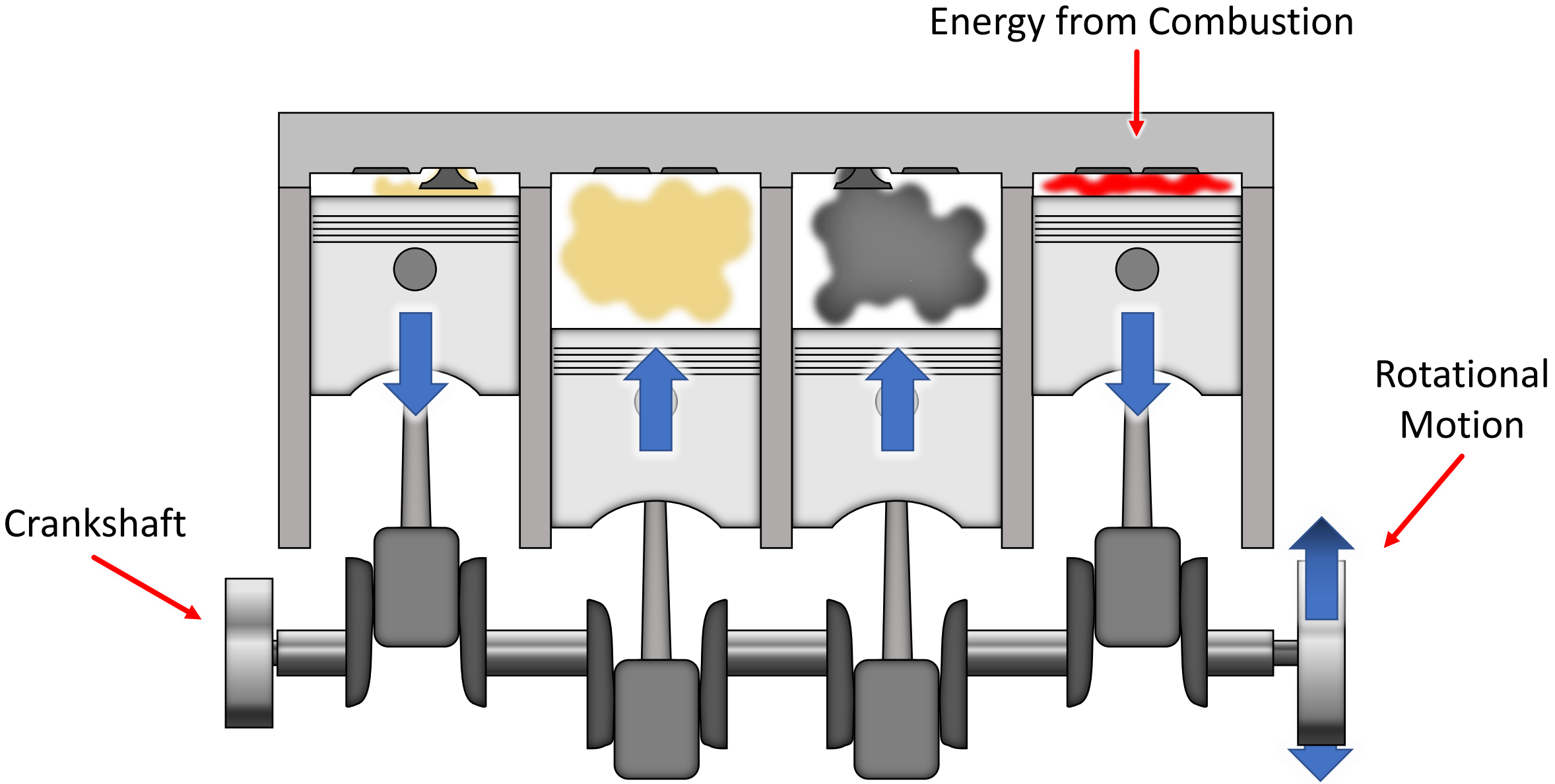
Engine

Inline 4-Cylinder Engine

Balanced Motion of Pistons

Cylinder 1	**Cylinder 2**	**Cylinder 3**	**Cylinder 4**
Induction Stroke	Compression Stroke	Exhaust Stroke	Power Stroke




Energy from Combustion
Rotational Motion
Crankshaft

Engine

Internal Combustion Engine – Hybrids

youtube.com/watch?v=uoBuOQn9XAQ

Engine

Requirement 5b – Engine Oil

Explain the purpose of engine oil.

Explain the API service code, the SAE number, and the viscosity rating.

Engine

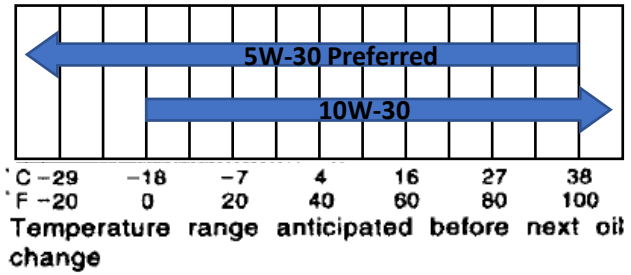
Engine Oil – Purpose

- Lubricate engine parts
- Reduce friction
- Clean, cool and protect the engine
- Prevents acid build up

Engine

Engine Oil – Viscosity

- Viscosity refers to how easily oil pours at a specific temperature
- Lower viscosity oils are often use for lower temperatures
  - Flows easier
- Higher viscosity oils are often use for higher temperatures
  - Thick oils maintain oil pressure in hotter temperatures
  - Improve film strength
  - Support heavier loads



Images Source: 1997 Toyota Camry Owner's Manual

Engine

Engine Oil – API

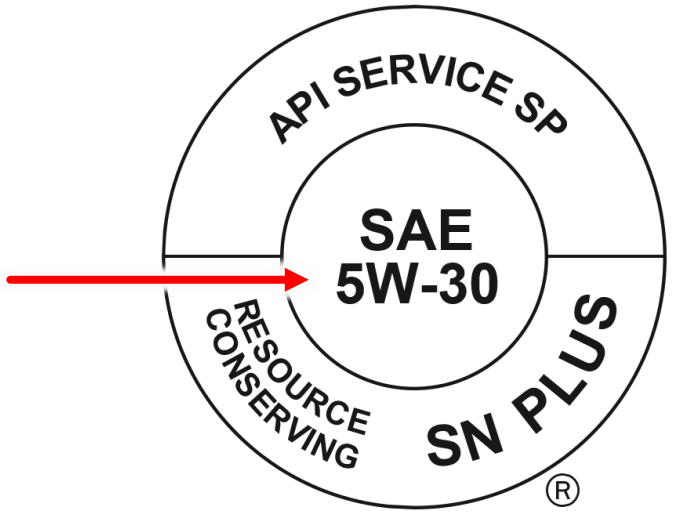
- API stands for the American Petroleum Institute
- Engine Oil Licensing and Certification System (EOLCS)
  - Stamp of approval
  - Minimum standards set by engine and vehicle manufacturers

https://www.api.org/-/media/Files/Certification/Engine-Oil-Diesel/Publications/Branding%20Guideline%20Final.pdf

Engine

Engine Oil – Motor Oil Grades

- SAE stands for the Society of Automotive Engineering
- The motor oil grade is usually written as follows “XW-XX”
  - SAE 10W-30
  - SAE 10W-40
  - SAE 30

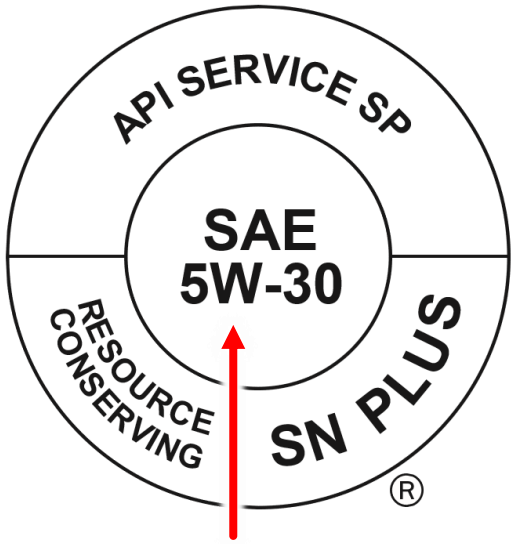


https://www.api.org/-/media/Files/Certification/Engine-Oil-Diesel/Publications/Branding%20Guideline%20Final.pdf

Engine

Engine Oil – Motor Oil Grades

- W means “Winter”
  - Oil flow at 0° Fahrenheit
  - In cold climates - 0W or 5W viscosity may be ideal

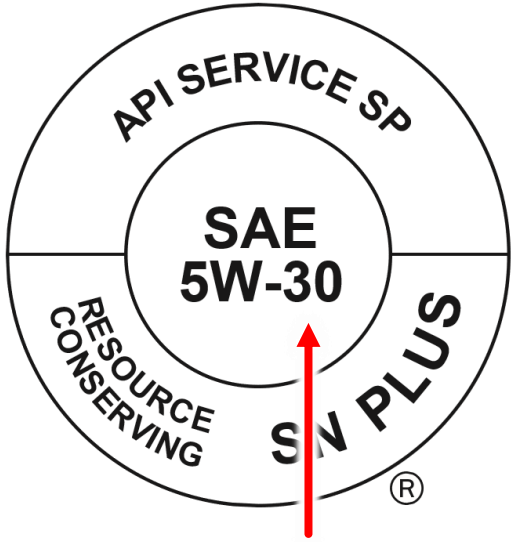


https://www.api.org/-/media/Files/Certification/Engine-Oil-Diesel/Publications/Branding%20Guideline%20Final.pdf

Engine

Engine Oil – Motor Oil Grades

- Number following the “W” is oil viscosity when “hot”
  - Oil flow at 212° Fahrenheit
  - 10W-30 oil with thin out more quickly than 10W-40 at high temps



https://www.api.org/-/media/Files/Certification/Engine-Oil-Diesel/Publications/Branding%20Guideline%20Final.pdf

Engine

Requirement 5c – Engine Oil for your Car

Explain where to find the recommended oil type and the amount of oil to be used in the vehicle's engine.

Engine

Engine Oil for your Car

Example of Owner's Manual

ENGINE LUBRICATION

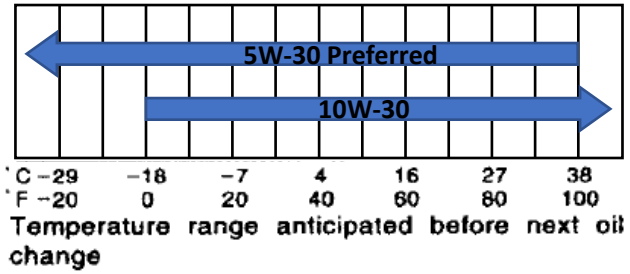
Oil capacity (drain and refill), L (qt., Imp. qt.):

5S-FE engine	
With filter	3.6 (3.8, 3.2)
Without filter	3.4 (3.6, 3.0)
1MZ-FE engine	
With filter	4.7 (5.0, 4.1)
Without filter	4.5 (4.8, 4.0)

Oil grade:

API SH, "Energy-Conserving II" multi-grade engine oil or ILSAC multigrade engine oil is recommended.

Recommended oil viscosity (SAE):



Temperature range anticipated before next oil change.

L70010

Images Source: 1997 Toyota Camry Owner's Manual

Cooling System

Cooling System

Requirement 6a – Cooling System

Explain the need for coolant in the cooling system, and the importance of selecting the correct coolant type for a given vehicle.

Cooling System

Cooling System – Coolant

- Cooling system used to keep engine in proper temperature range
  - If engine gets too hot, it will seize

- Coolant serves serval functions
  - Coolant raises the boiling point of the cooling system in summer
  - Lowers the freezing point in winter
  - Protects the engine and cooling system from corrosion

Cooling System

Cooling System – Coolant Types

- Different types of coolants are used in different vehicles
  - Inorganic Additive Technology (IAT)
    - Requires changing every 2 years or 24,000 miles
  - Organic Acid Technology (OAT)
    - Requires changing every 5 years or 50,000 miles
  - Hybrid Organic Acid Technology (HOAT)

Cooling System

Cooling System – Coolant Colors

- Don’t depend on the color of coolant

TYPE	INHIBITOR TECHNOLOGY	VEHICLES	COLOR
IAT (Inorganic Additive Technology)	Silicates	Older Vehicles	GREEN
OAT (Organic Acid Technology)	Organic Acids	GM, Saab, VW	ORANGE
HOAT (Hybrid OAT)	Silicates & Organic Acids	Ford, Chrysler, European	YELLOW
HOAT (Hybrid OAT, Phosphate-free)	NAP Free	BMW, Volvo, Tesla, Mini, others	TURQUOISE
P-HOAT (Phosphated HOAT)	Phosphates & Organic Acids	Toyota, Nissan, Honda, Hyundai, KIA & other Asian vehicles	PINK / BLUE
Si-OAT (Silicated HOAT)	Silicates & Organic Acids	Mercedes-Benz, Audi, VW, Porsche, others	PURPLE

Cooling System

Cooling System – Coolant Types

- Different vehicles require different coolants
- Each coolant is specifically formulated
  - Keeps its designated engine type running in extreme temperatures
- It is important to use the correct antifreeze for your vehicle

Cooling System

Requirement 6b – Cooling System Flush and Change

Explain how to flush and change the engine coolant in the vehicle, and how to properly dispose of the used coolant.

Cooling System

Cooling System – The Flush

- Buy the right Coolant
- Buy a new thermostat and radiator cap
- Jack up car on jack stands
- Place a large drain pan under vehicle
- Disconnect lower radiator hose or drain plug
- Allow to drain
- Replace lower radiator hose or drain plug
- Fill with water
- Run engine with heater on high and allow to cool
- Repeat flush – use distilled water if concerned about minerals in water
- Replace coolant
- Run engine and top off as needed

Cooling System

Cooling System – Coolant Disposal

- Coolant is toxic
  - It will kill pets that drink it
  - Toxic to human too
- Transport in sealed container

- Where do I take it?
  - Snohomish County
  - King County

Fuel System

Fuel System

Requirement 7a – Air and Fuel Systems

Explain how the air and fuel systems work together and why it is necessary to have an air filter and fuel filter.

Fuel System

Air and Fuel Systems

- Internal combustion engine needs metered and clean fuel and air
  - Metering
    - Proper ratio of air and fuel required for proper combustion
  - Filtering
    - Dirt and dust particles will destroy engine

Fuel System

Air and Fuel Systems – Fuel

- Fuel
  - Stored in tank – often in rear of vehicle
  - Pumped to engine via one or more fuel pumps
  - Filtered to prevent solid particle from entering injectors and engine
  - Fuel regulator regulates pressure of fuel entering injectors
  - Injectors allow fuel to enter cylinder

Fuel System

Air and Fuel Systems – Fuel

- Air
  - Intake bring air through filter
  - Mass air flow sensor is often used to measure incoming air
  - Throttle body opens and closes to adjust air flow
  - Air passes throttle body into intake manifold
  - Fuel injectors spray fuel into air in intake manifold
  - Air mixed with fuel enters cylinder when intake valve opens
  - Combustion occurs in cylinder
  - Exhaust exists exhaust valve into exhaust system

Fuel System

Requirement 7b – Fuel Injection

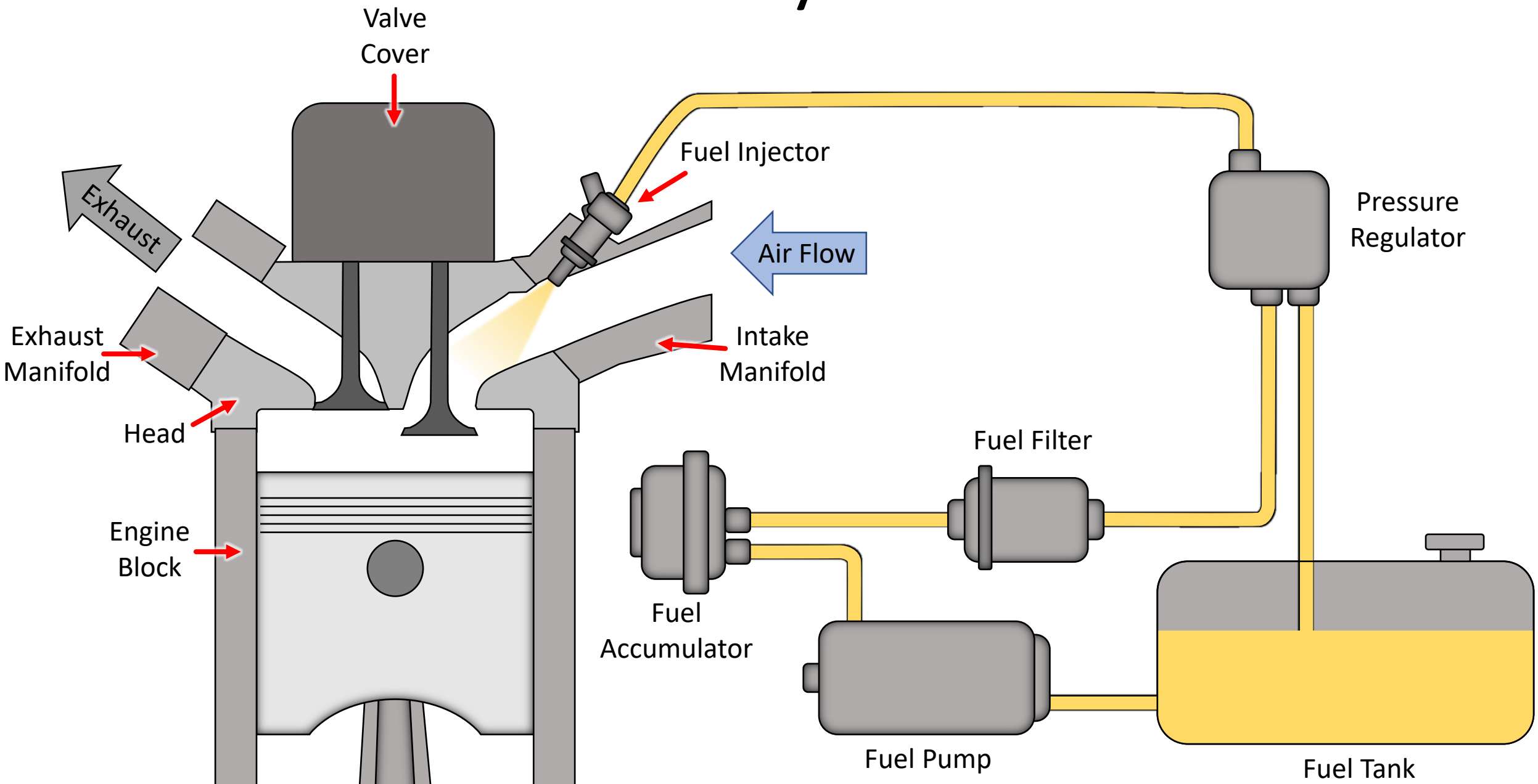
Explain how a fuel injection system works and how an on-board computer works with the fuel injection system.

Fuel System

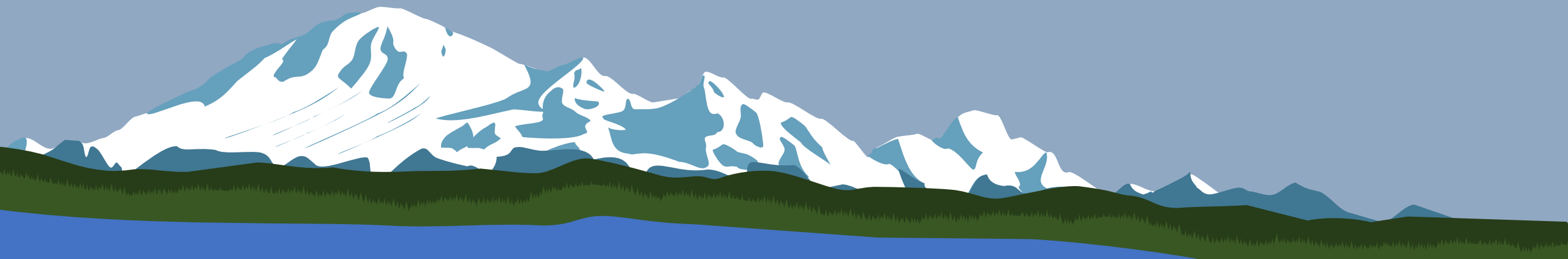
Fuel Injection

- Computer manages:
  - Timing of ignition
  - Air Fuel mixture
    - Does this by opening and closing fuel injectors
    - Longer pulses sent to injectors = more fuel delivered to cylinder
- Uses information:
  - How much air is coming in
    - Mass Air Sensor (MAS) or
    - Manifold absolute pressure (MAP) sensor
  - Throttle Potion Sensor (TPS)
  - Engine speed

Fuel System


Valve Cover
Fuel Injector
Exhaust
Air Flow
Pressure Regulator
Exhaust Manifold
Intake Manifold
Head
Fuel Filter
Engine Block
Fuel Accumulator
Fuel Pump
Fuel Tank

Ignition and Electrical Systems



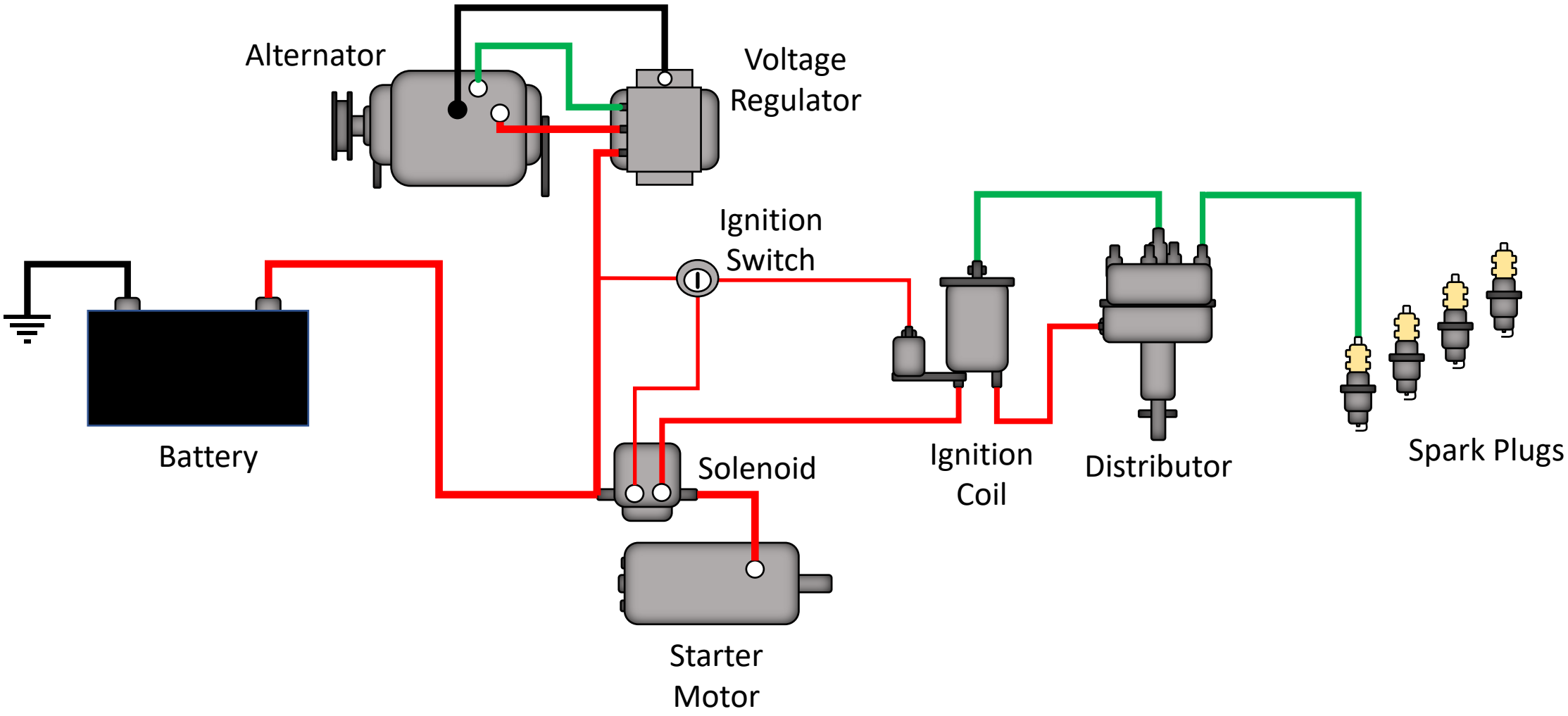
Ignition and Electrical System

Requirement 8a –Electrical System Parts

Diagram and explain the parts of the electrical system.

Ignition and Electrical System

Electrical System Parts



Ignition and Electrical System

Electrical System Parts

- **Battery**
  - Stores electricity
- **Alternator**
  - Produces electricity when engine is running
- **Voltage Regulator**
  - Control voltage output from alternator
- **Ignition Switch**
  - Turns everything on

Ignition and Electrical System

Electrical System Parts

- **Starter Solenoid**
  - Relay – sends large electrical current to starter

- **Starter**
  - Electric motor turns over engine to start it

Ignition and Electrical System

Electrical System Parts

- **Ignition Coil**
  - Induction coil that transforms low voltage into thousands of volts

- **Distributor**
  - Times and sends electrical current to Spark Plugs

- **Spark Plugs**
  - Produces high voltage spark in combustion chamber

Ignition and Electrical System

Requirement 8b – Firing Order

Explain the engine's firing order.

Ignition and Electrical System

Firing Order

The firing order is the sequence of ignition for the cylinders

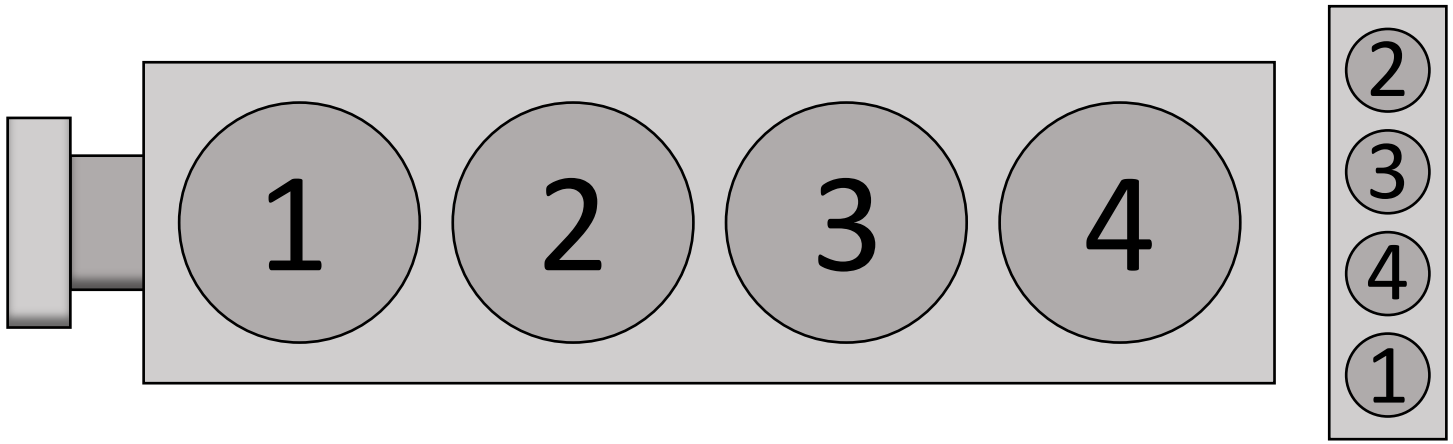
Common Firing Orders:

- Inline Four Cylinder engines typically 1-3-4-2
- Inline Six Cylinder engines 1-5-3-6-2-4
- V6 engines (90 degree angle) R1-L2-R2-L3-L1-R3 or R1-L3-R3-L2-R2-L1
- Several V6 engines with 60 degree angle - R1-L1-R2-L2-R3-L3.
- V8 engines use various different firing orders
    - Even same manufactures use different firing orders

Ignition and Electrical System

Firing Order

Camry 4 Cylinder 1-3-4-2

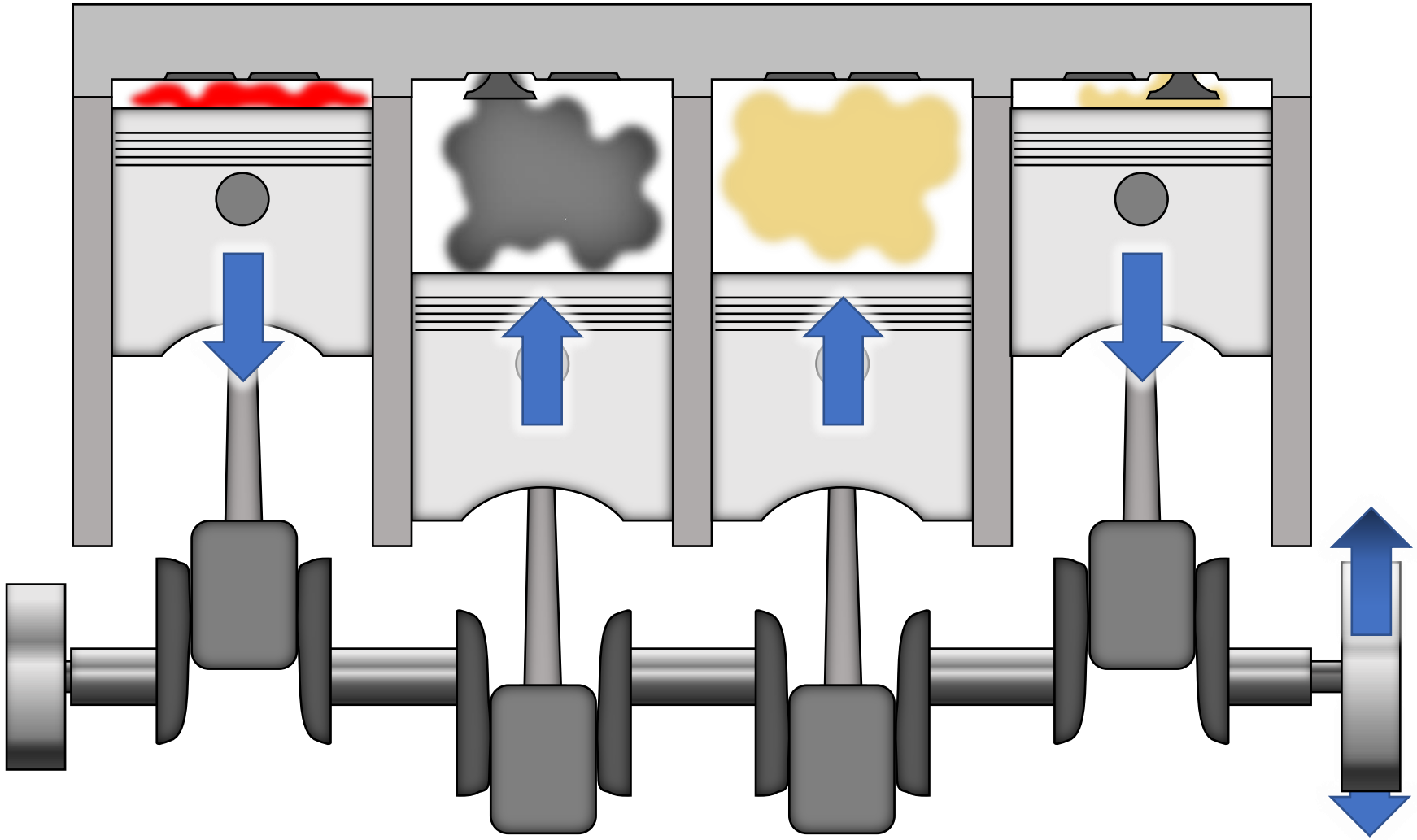


Front of Vehicle

Camry 4-Cylinder 1-3-4-2 Firing Order

Cylinder 1
Fires First

Cylinder 3
Fires Next



Balanced
Motion

Ignition and Electrical System

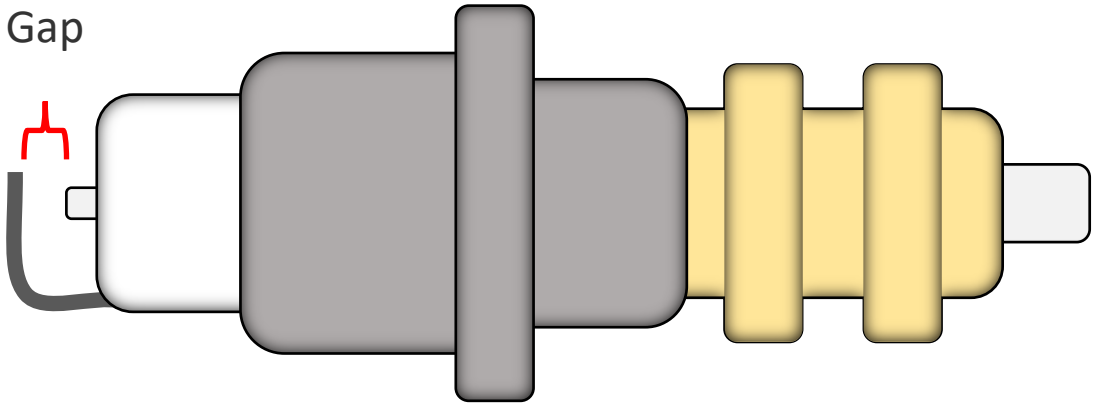
Requirement 8c – Spark Gap

Explain the purpose of the spark gap.

Ignition and Electrical System

Spark Gap

- The Spark Gap is the distance between the center and side electrodes
  - Proper gap is needed so that arcing occurs
  - Arcing results in combustion in cylinder



Ignition and Electrical System

Requirement 8d – Jumper Cables

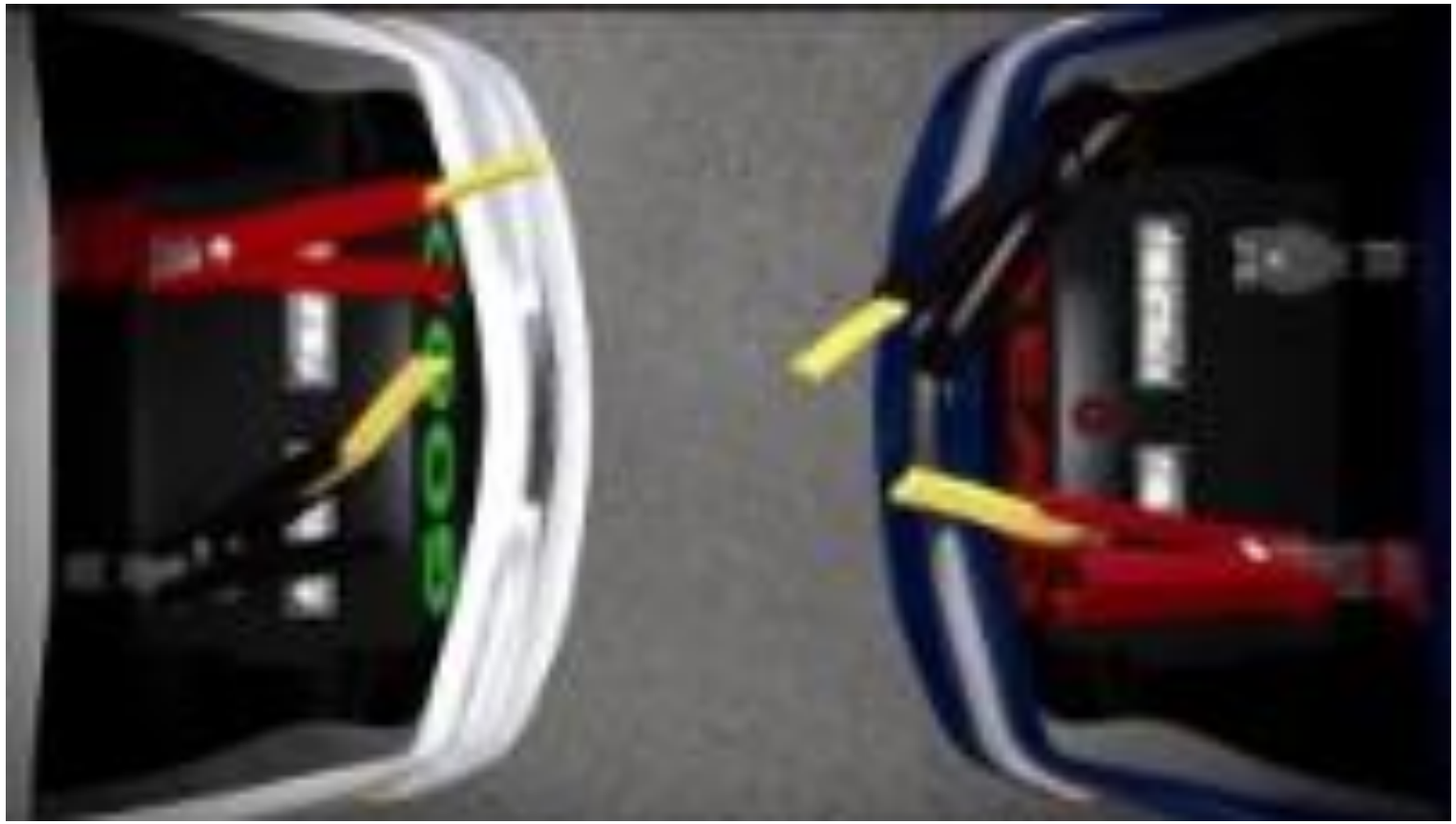
Demonstrate how to safely connect jumper cables to your car battery.

This requirement MUST be done with an experienced Adult

Ignition and Electrical System

Jumper Cables

Demonstrate how to safely connect jumper cables to your car battery.



youtube.com/watch?v=Ec5P9pISGPk

Drivetrain

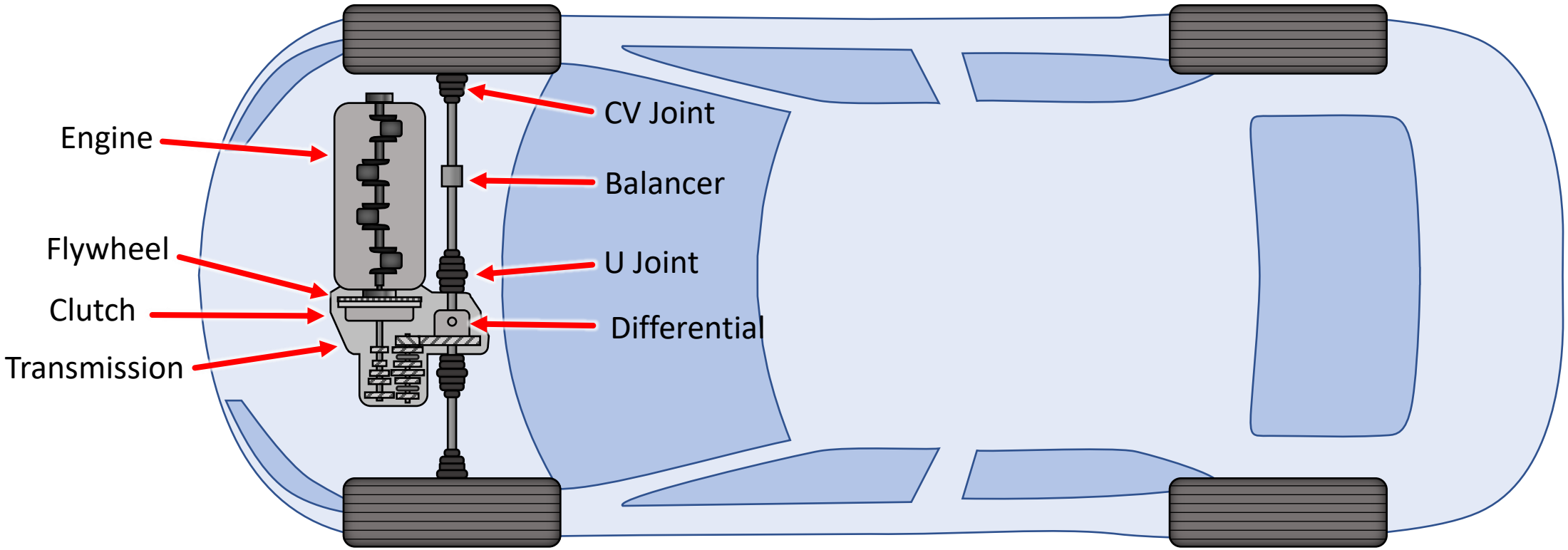
Drivetrain

Requirement 9a – Drivetrain

Diagram the drive train and explain the different parts.

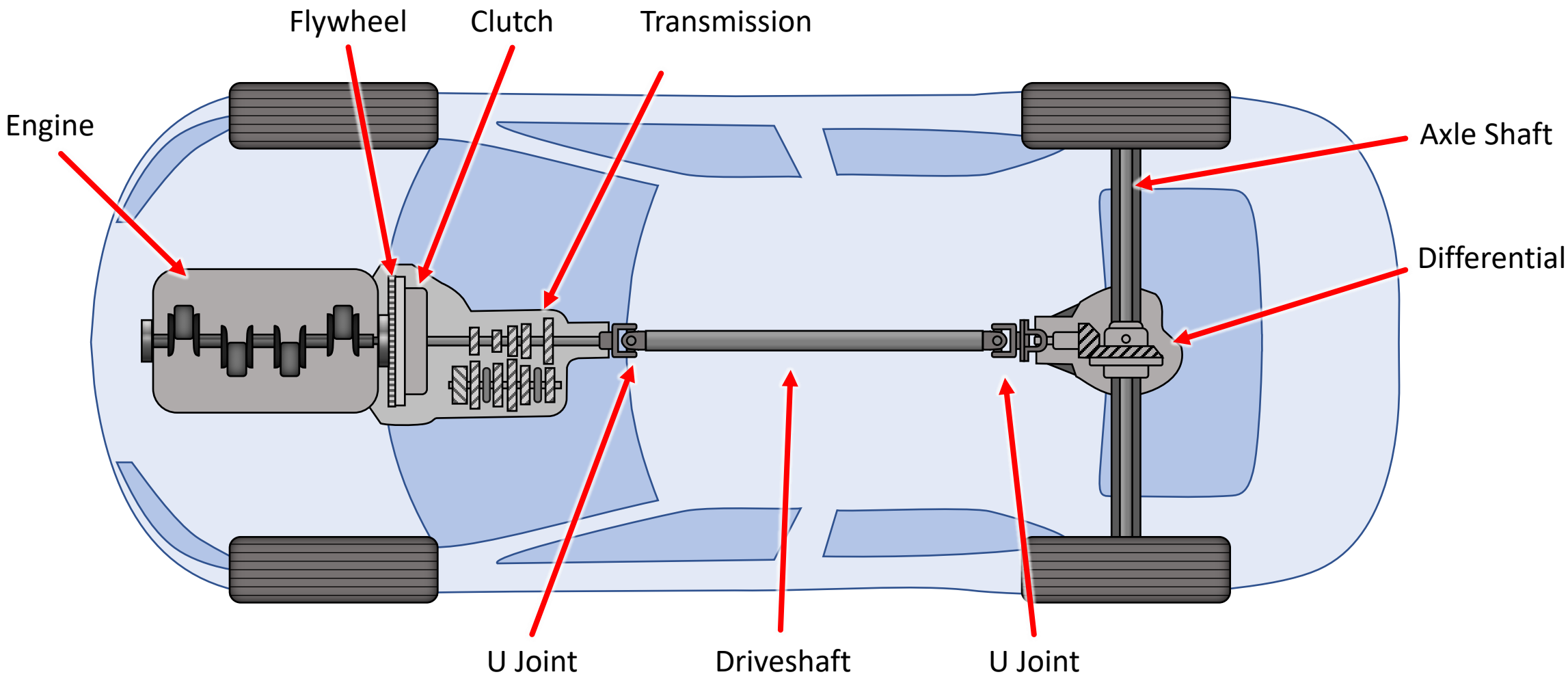
Drivetrain

Transversely Mounted Engine Layout



Drivetrain

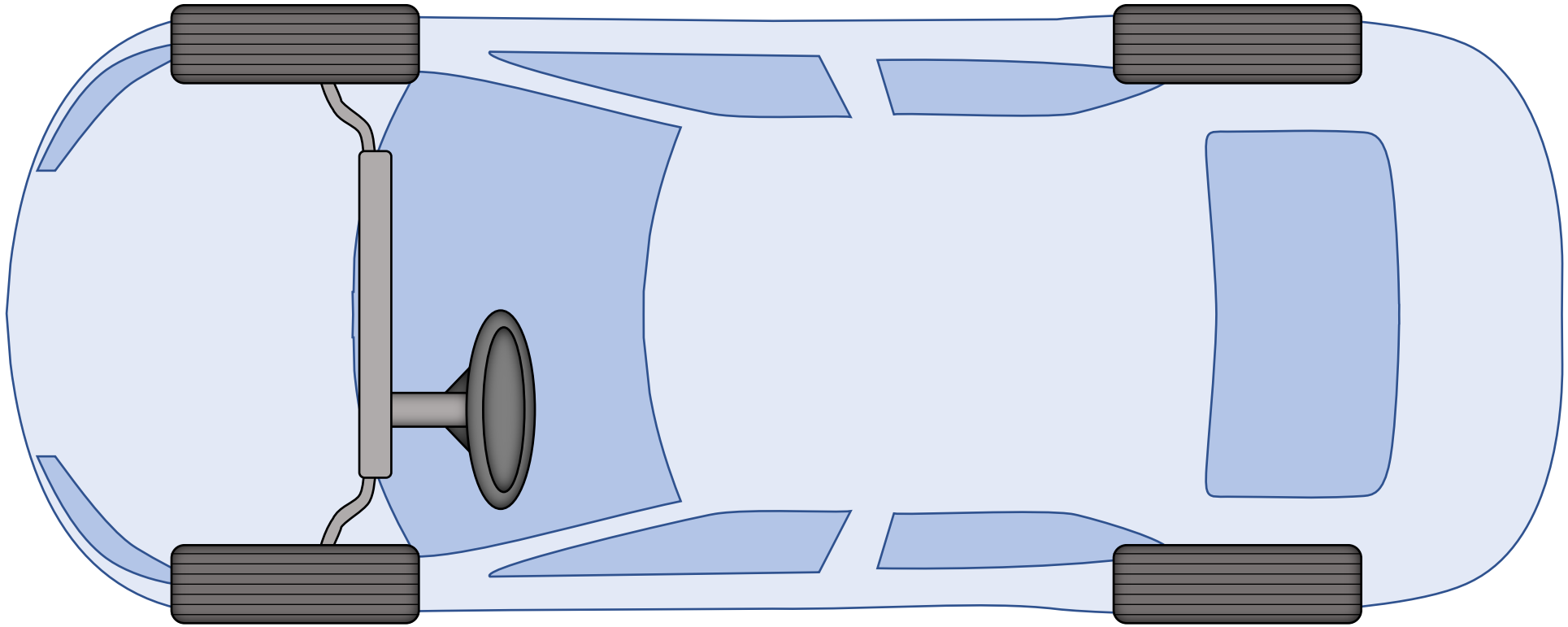
Inline Mounted Engine Layout



Drivetrain

Drivetrain

Diagram the drive train and explain the different parts.



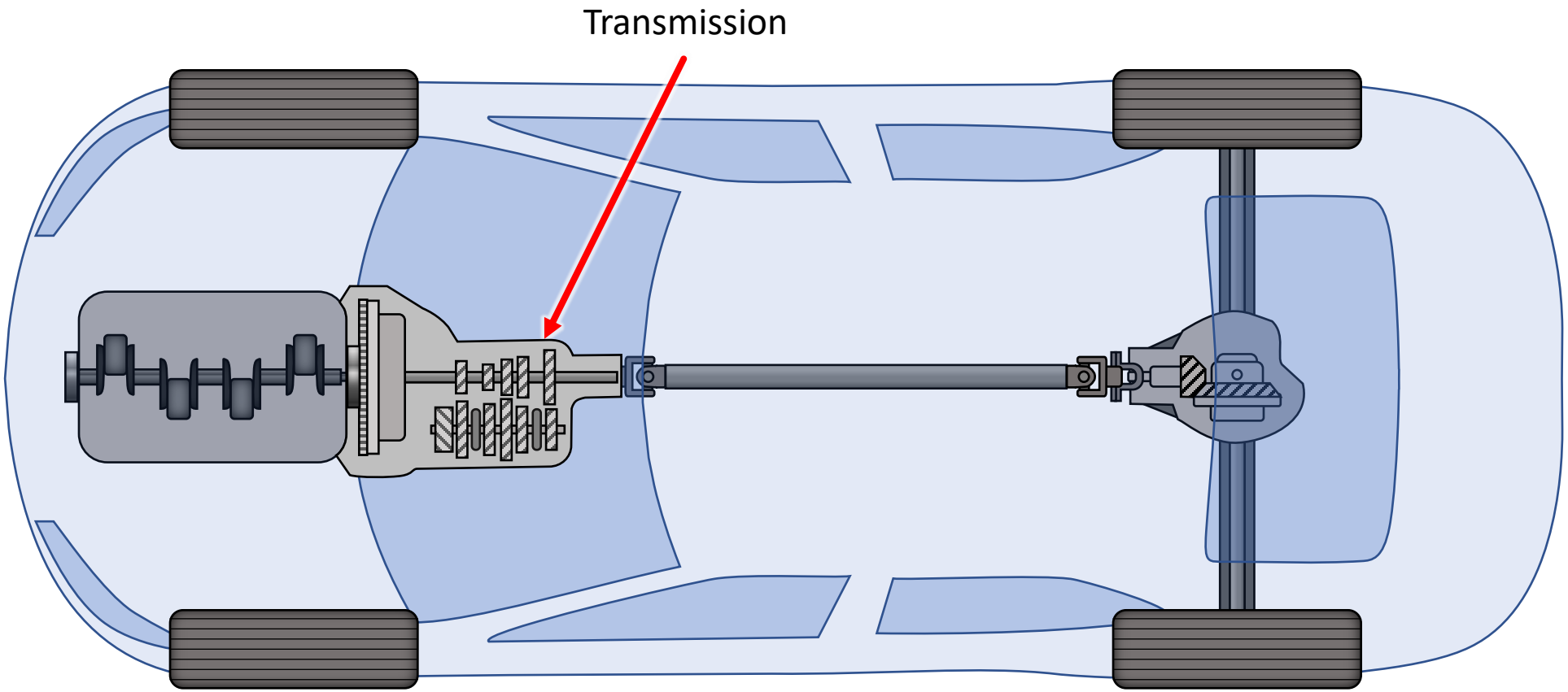
Drivetrain

Requirement 9b – Transmission

Explain the difference between automatic and standard transmissions.

Drivetrain

Transmission



Drivetrain

Transmission

- Transforms power from engine to axles
- Uses gears to provide speed and torque conversion

Drivetrain

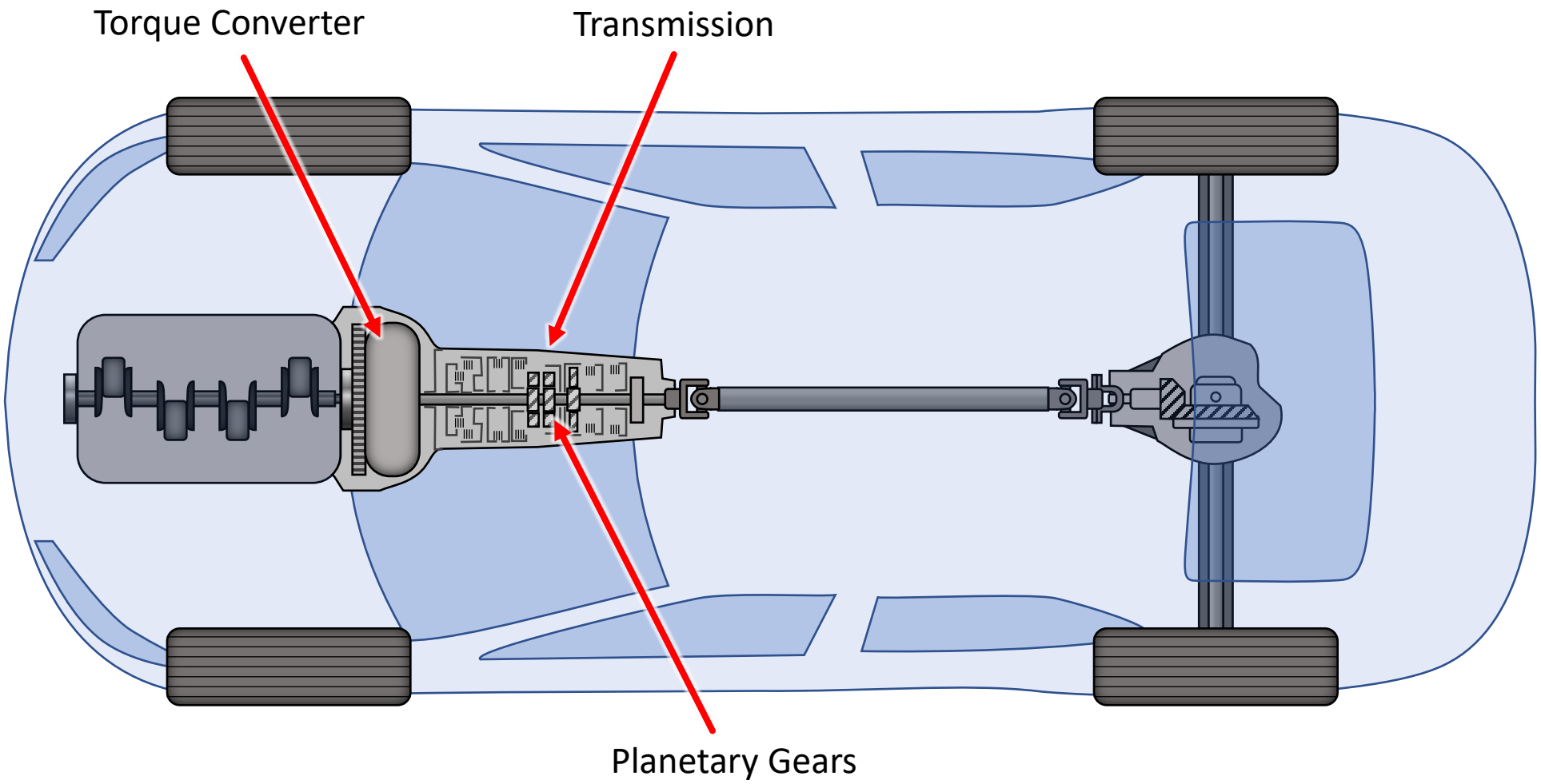
Transmission

Transmissions come in 2 basic types:

- Standard Transmission
- Automatic Transmission

Drivetrain

Automatic Transmission



Drivetrain

Transmission – Automatic

Most modern North American cars have an automatic transmission

- Allows for gear shifting without driver input
- More complex than standard transmission
- More expensive than standard transmission
- Older designs had reliability issues and were less fuel efficient

Drivetrain

Transmission – Automatic

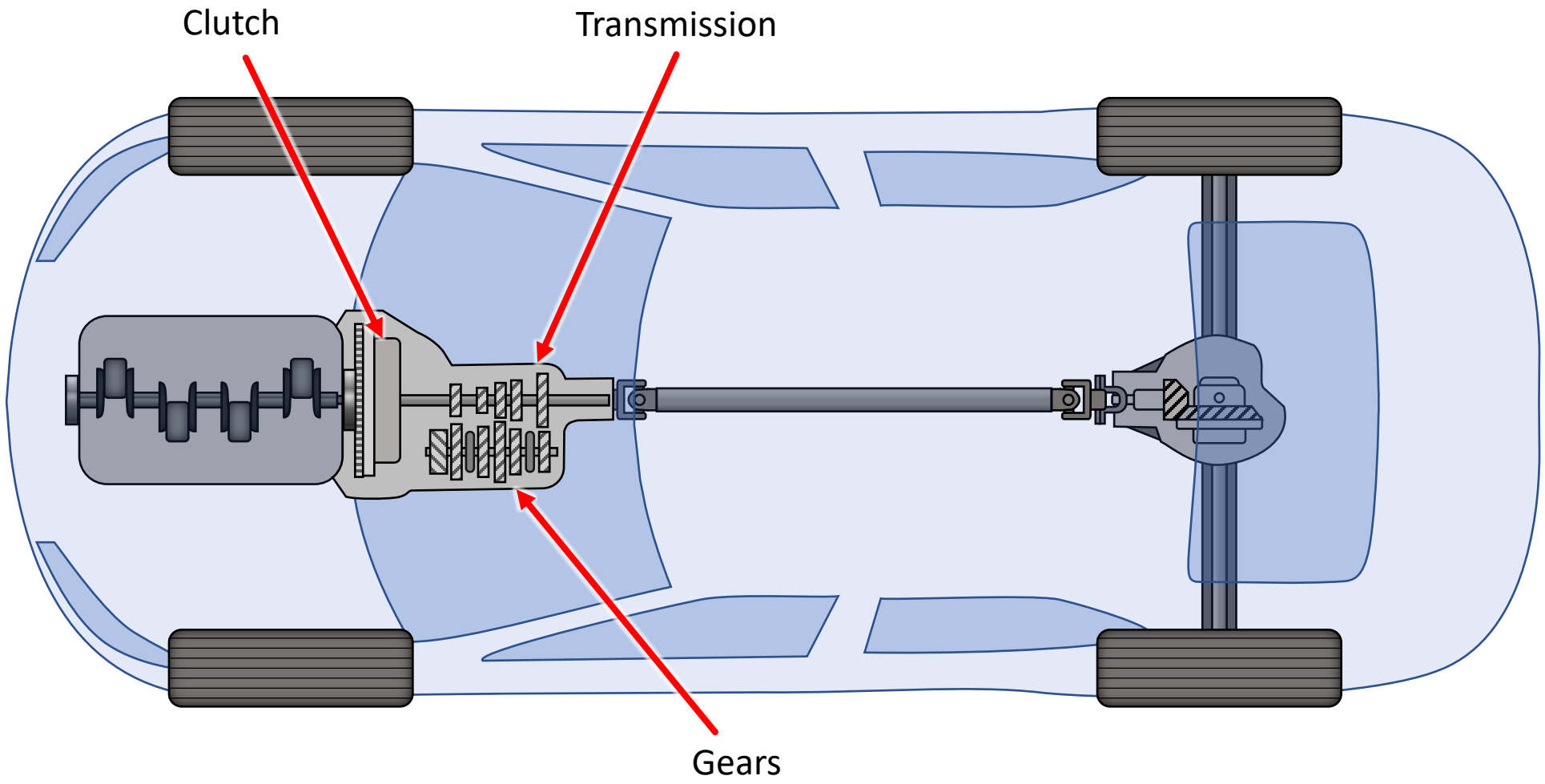
Automatic Transmission uses:

- Torque Converter
  - Allows for multiplication of torque
  - Allows coupling and decoupling of the engine (like clutch)
- Hydraulic Controls
  - Friction bands and clutches are controlled via hydraulic pressure
  - This is how the transmission “automatically” shifts
- Planetary Gears

- Art of Manliness does a great job of explaining how this work

Drivetrain

Standard Transmission



Drivetrain

Transmission – Standard

- Most common transmission type outside North America and Australia
- Simpler design than automatic
- Less expensive to build
- Lighter
- Easier to maintain
- Allows for push starting vehicle
- Requires a level of skill to use
  - Hill starts can be challenging
  - Some terrain and roads requires constant driver input
  - Enhances Fahrvergnügen [pleasure of driving]

Drivetrain

Transmission – Standard

Standard Transmission (aka Manual Transmission) uses:

- Clutch - this disengages power from engine
- Gears
- Shift lever

Drivetrain

Transmission

www.youtube.com/watch?v=auQgOtveQi0

Drivetrain

Requirement 9c – Automatic Transmission Fluid

Explain the types of automatic transmission fluid.

Drivetrain

Automatic Transmission Fluid

Automatic Transmission Fluid (ATF) does a number of things

- Lubrication
- Cooling
- Clutch application
  – acts as a “glue” between clutches
- Connects Engine and Transmission
  - Hydraulic coupling in Torque Converter

Drivetrain

Automatic Transmission Fluid

Basic Types of ATF

- Type A
- Type F
- Dexron III/Mercon
- High Friction Modified – Style Fluids

Drivetrain

Automatic Transmission Fluid

Type A

- Used in the 1950s by GM vehicles

Drivetrain

Automatic Transmission Fluid

Type F

- Used bye Ford and Toyota in 1967
- You might use this if you have a classic car

Drivetrain

Automatic Transmission Fluid

Dexron III/Mercon

- Most commonly used ATF used
- Use if owner’s manual calls for Dextron or Mercon

Drivetrain

Automatic Transmission Fluid

HFM-Style Fluids

- Highly Friction Modified
- Different friction characteristics than Dexron III/Mercon
- Used by a number of manufactures
  - Chrysler
  - Honda/Acura
  - Jeep/Eagle
  - Hyundai
  - Toyota/Lexus
  - Saturn
  - Sterling

Drivetrain

Automatic Transmission Fluid

Check your Owner's Manual as there are many specific types:

- Type A Transmission Fluid
- Type F Transmission Fluid
- Dexron
- Dexron II
- Dexron IIE
- Mercon Type CJ
- Mercon Type H
- Ford Mercon
- Dexron III (H)
- Dexron III/Saturn
- C-4 Torque Fluid
- Dexron-VI
- Mercon V
- Mercon SP
- Mitsubishi Diamond SP-II & SP-Ill
- Nissan HP/J-Matic
- Toyota Type T, T-III, T-IV
- Genuine Honda ZL ATF
- BMW LT7114l or LA2634
- Chrysler ATF+4 (ATE)
- Chrysler 7176
- Chrysler 7176D (ATF+2)
- Chrysler 7176E (ATF+3)
- Plus Specialty ATFs

Drivetrain

Requirement 9d – Gear Oil

Explain the types of lubricants used in a standard transmission, and in the differential and transfer case.

Drivetrain

Gear Oil

There are dozens of types of gear lube for your manual transmission

- Many modern manual transmission use ATF
- Gear oil is specially formulated to lube the metals in your transmission
  - Hardened steel used in gear
  - Brass synchronizers
- You need to select the proper oil for your transmission or transfer case

Drivetrain

Gear Oil

- GL-4 oils – typically found in most daily driven cars
- GL-5 oils – typically used for trucks and high-powered cars
- MT-1 oil – intended for non-synchronized transmissions
  - Heavy-duty commercial trucks
  - Certain 4-wheel drive transfer cases

- API Categories GL-1, GL-2, GL-3 and GL-6 were declared inactive by SAE Technical Committee 3 in 1995

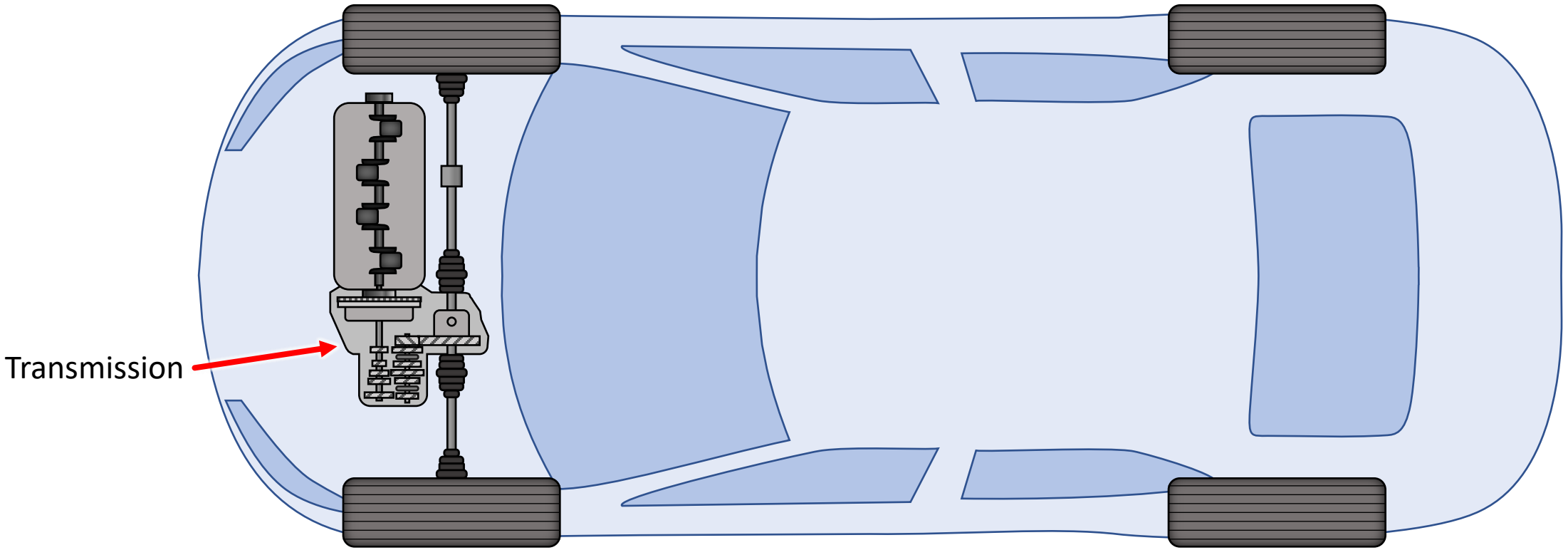
Drivetrain

Requirement 9e – Drivetrain

Explain the difference between front-wheel, rear-wheel, and four-wheel drive.

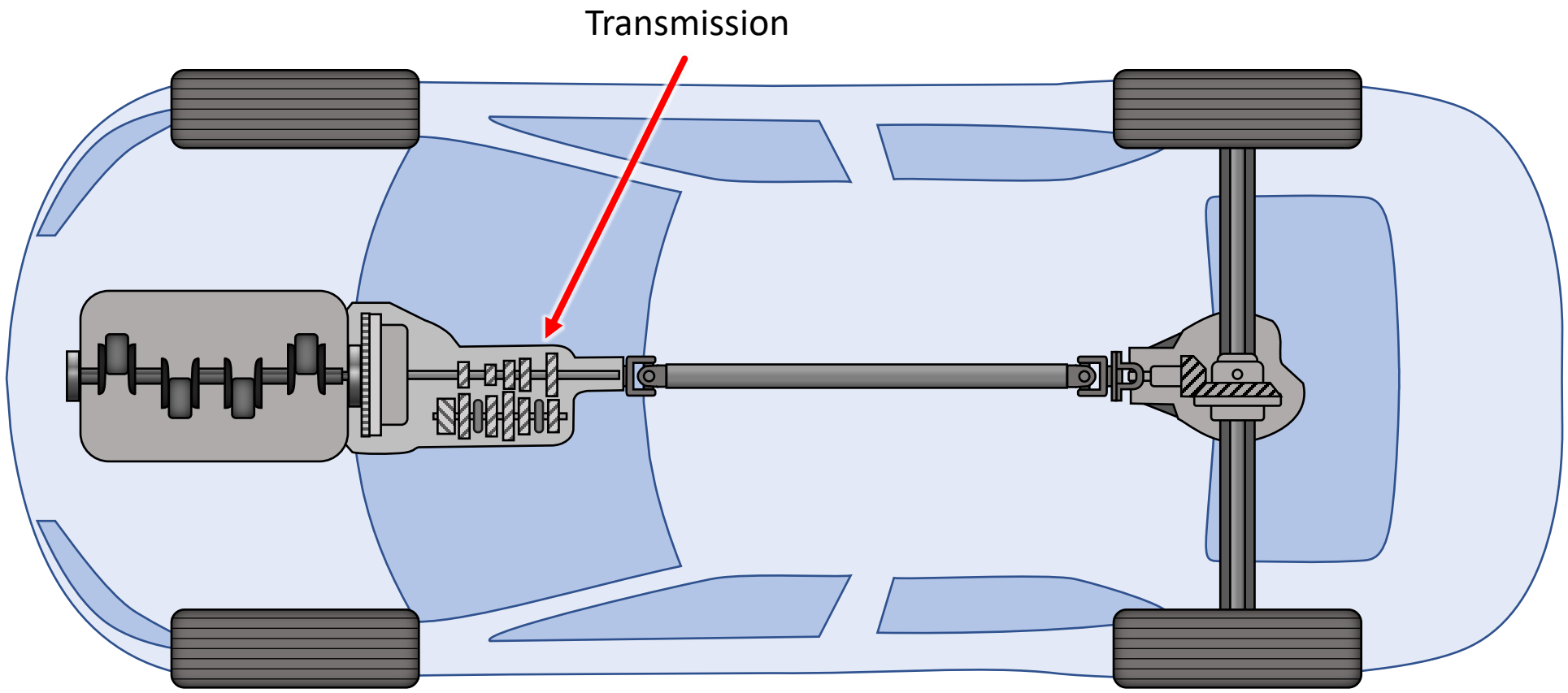
Drivetrain

Engine Front, Front Wheel Drive



Drivetrain

Engine Front, Rear Wheel Drive

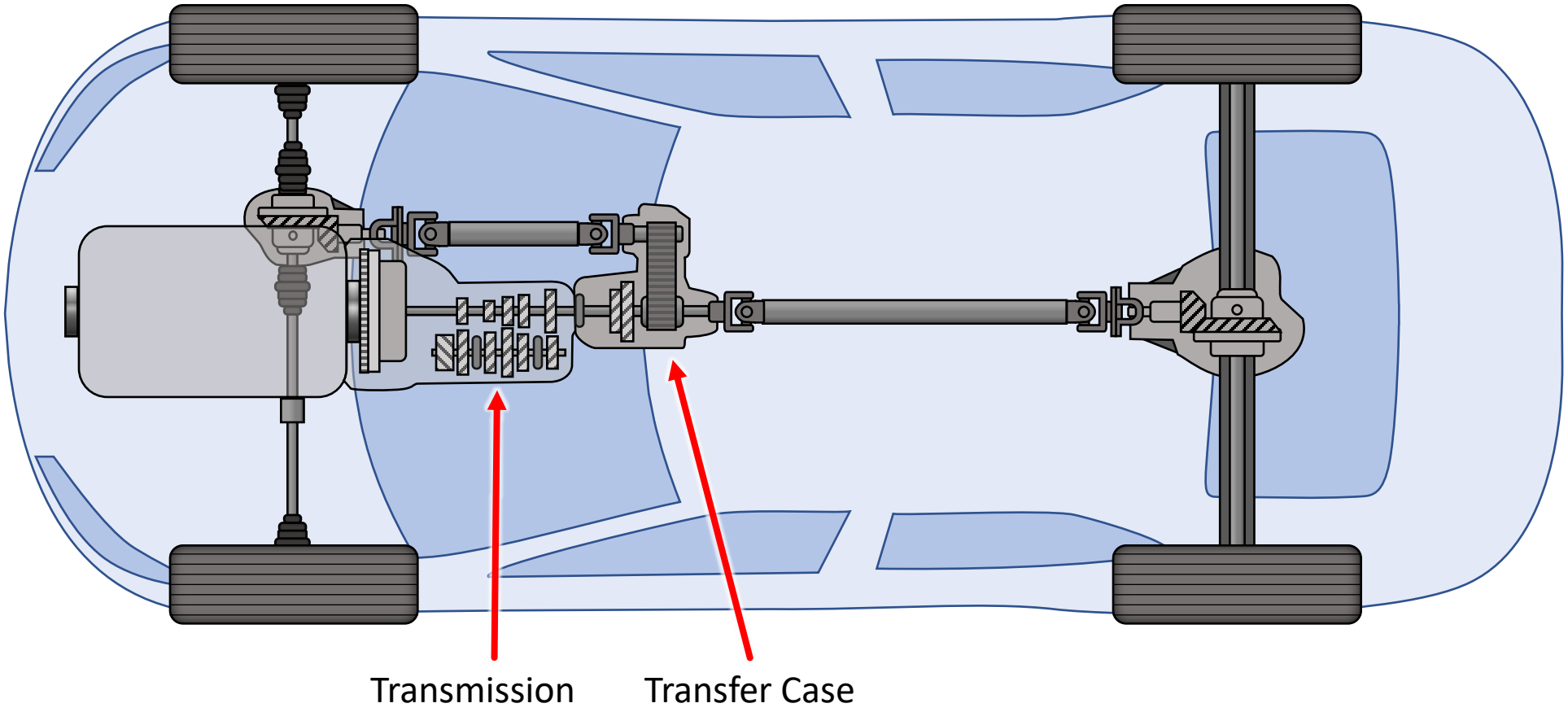


Drivetrain

Engine Front, 4 Wheel Drive

Transfer Case

- Used to shift between 2WD and 4WD
- May allow for Low and High gear



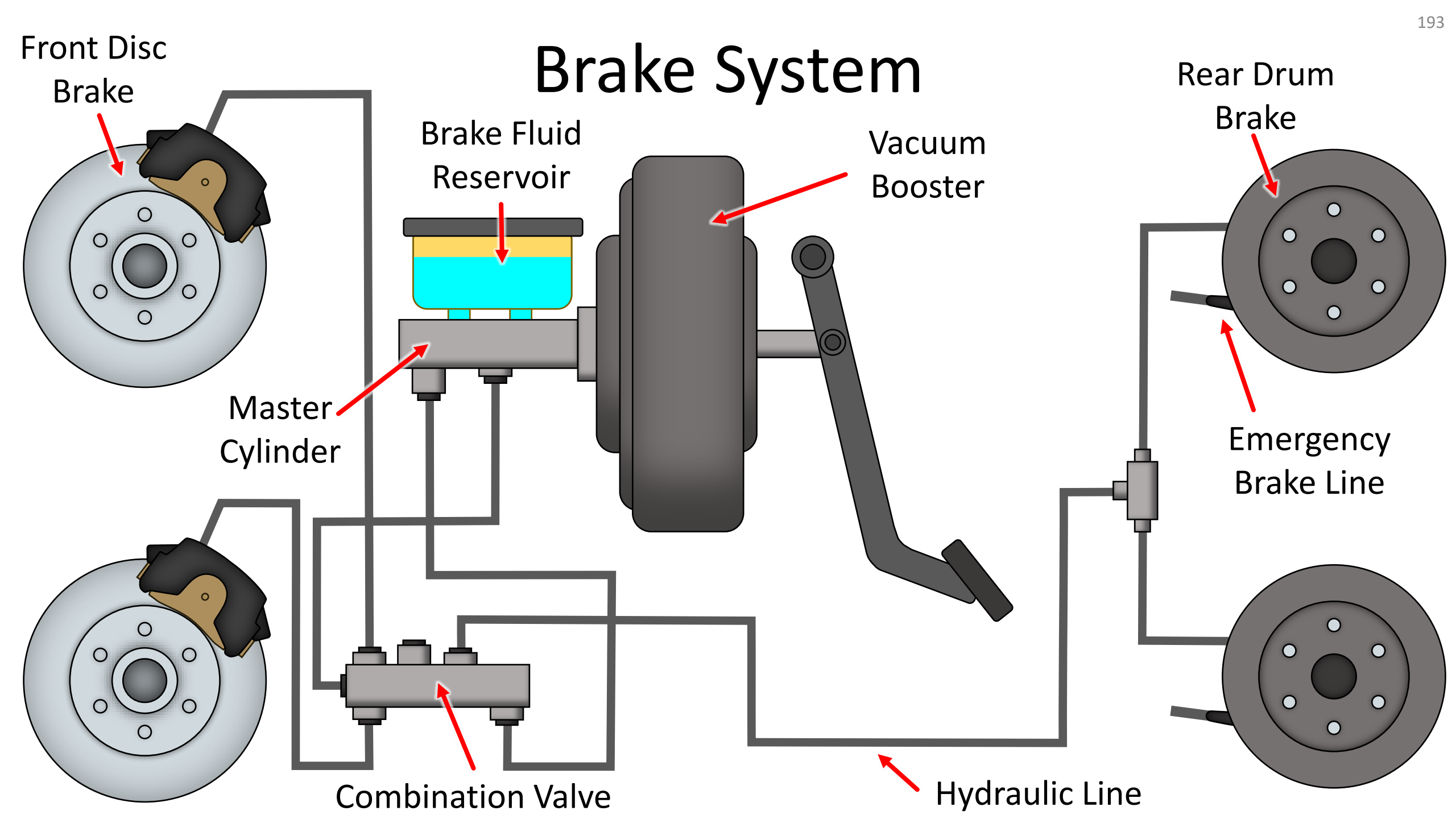
Brake System

Brake System

Requirement 10a – Brake System

Explain the brake system (including antilock systems) and how it operates.

Brake System



Brake System

Brake System

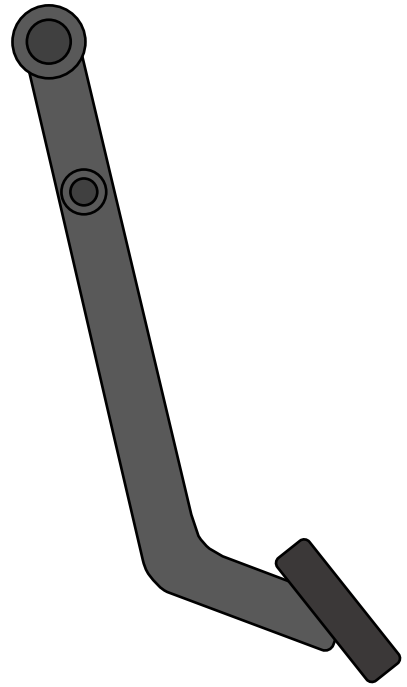
Brake system is made up of:

- Brake Pedal
- Vacuum Booster
- Master Cylinder
- Brake Fluid Reservoir
- Hydraulic Lines
- Combination valve and/or ABS Module
- Front Disc Brakes
- Rear Disc or Drum Brakes
- Emergency Brake
- Electronics – Sensors, Computer, etc.

Brake System

Brake System – Brake Pedal

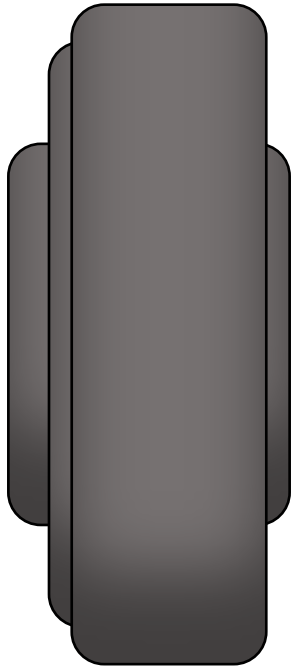
- Brake Pedal is a lever
- Pressing the Brake Pedal forces rod into the Master Cylinder



Brake System

Brake System – Vacuum Booster

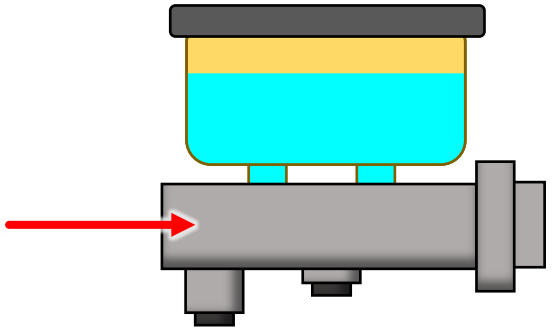
- Reduces the amount of pressure needed for braking
- Uses vacuum created by engine
- Vacuum increase the force of the brake pedal



Brake System

Brake System – Master Cylinder

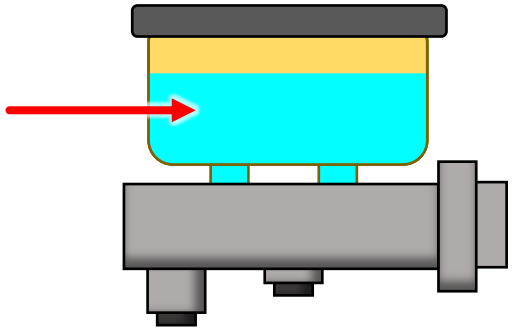
- Converts non-hydraulic pressure into hydraulic pressure
- Brake pedal is pressed:
  - Hydraulic fluid forced through Master Cylinder
- Brake pedal is released:
  - Hydraulic fluid returns to Master Cylinder



Brake System

Brake System – Brake Fluid Reservoir

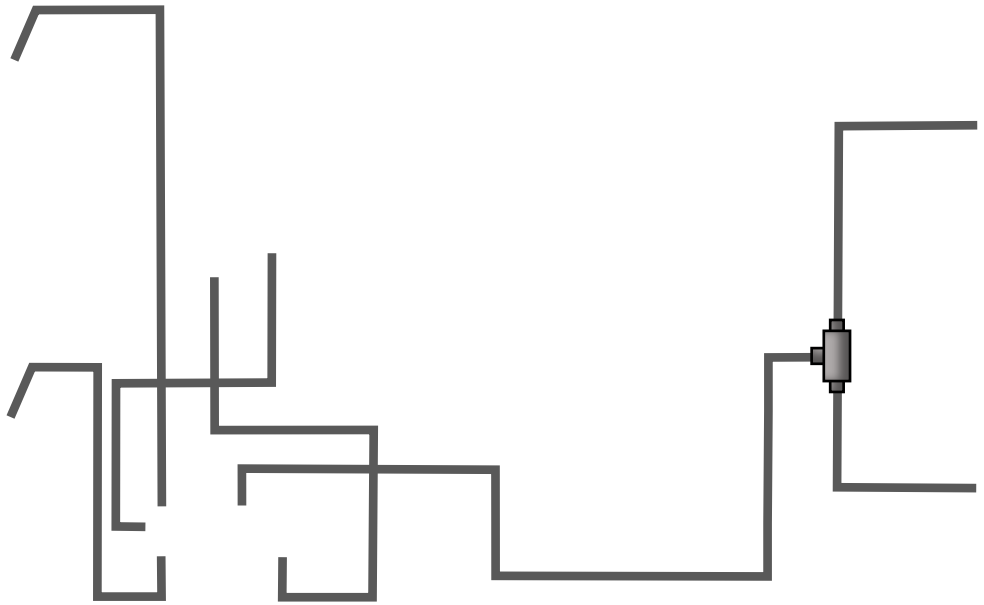
- Brake Fluid Reservoir store reserve hydraulic fluid
- Vital to keep air out of hydraulic system



Brake System

Brake System – Hydraulic Lines

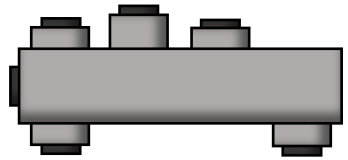
- Hydraulic Lines contain hydraulic fluid in pressurize system
- Connects parts of hydraulic system
  - From Master Cylinder
  - To Brake Cylinders



Brake System

Brake System – Combination Valve

- Combination valve has several components/functions:
  - **Proportioning Valve**
    keeps the rear brakes from locking up during a panic stop
  - **Metering Valve**
    delays the front brakes long enough for the fluid pressure to overcome the rear brake return springs
  - **Pressure Switch**
    sends an electrical signal for brake lights



Brake System

Brake System – ABS Control Module

- Braking power is reduced when wheels lock up and skid
- ABS works by releasing and reapplying pressure to brakes
  - ABS “pumps” the brakes 100’s of times per second

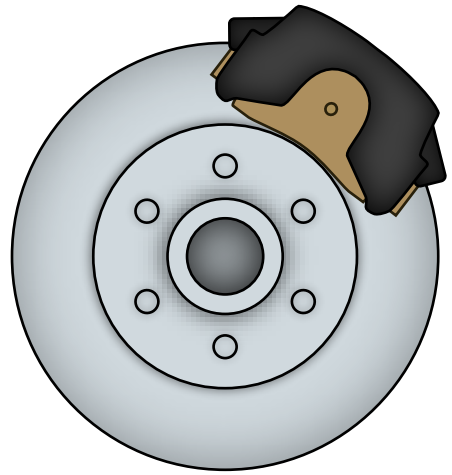
- ABS Control Module found on vehicles with ABS brakes
  - Performs diagnostic checks of the ABS braking system
  - Determines when to send the correct pressure to each wheel
  - Prevents wheels from locking up

- ABS Control Module may :
  - Replace the Combination Valve
  - Be in separate from a Combination Valve

Brake System

Brake System – Front Disc Brakes

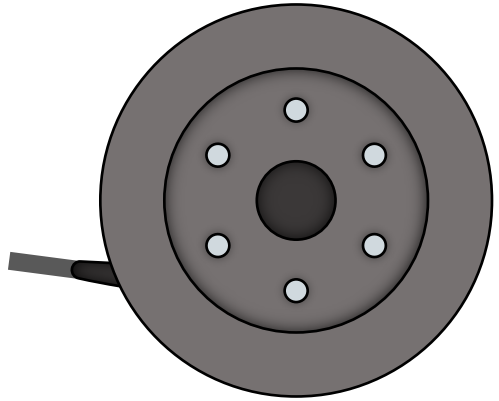
- Usually found on the front wheels
- Many vehicles also have disc brakes in rear
- Pads are attached to a brake caliper assembly that frames the rotor
- Brake pads press against a disc (rotor) when brakes are applied



Brake System

Brake System – Rear Disc or Drum Brakes

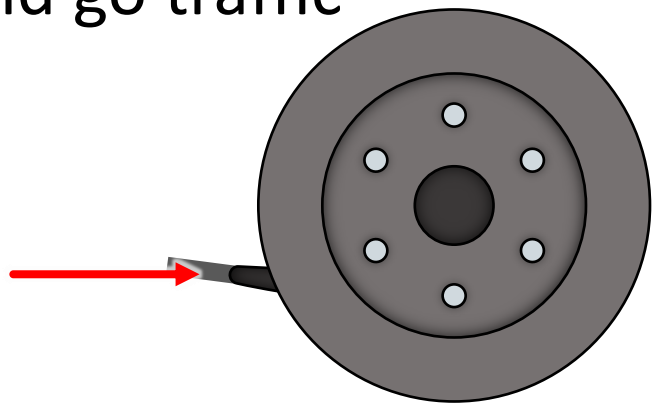
- Located on the rear of the vehicle
- Brake shoes are forced into the brake drum when brakes are applied
- Emergency brake is usually incorporated into rear brakes



Brake System

Brake System – Emergency Brake

- Operates independently of the main brake system
- Mainly used to hold vehicle stationary when parked
- Other uses:
  - Used in emergency if hydraulic system fails
  - Starting vehicle with a standard transmission when going uphill
  - Stopping your vehicle from rolling in stop and go traffic
  - Racing and off-road techniques



Brake System

Brake System – Electronics

- ABS system requires several electronic comports
- Wheel speed sensors
- ABS ring
- ECU or separate braking module
- Wiring
- Lights

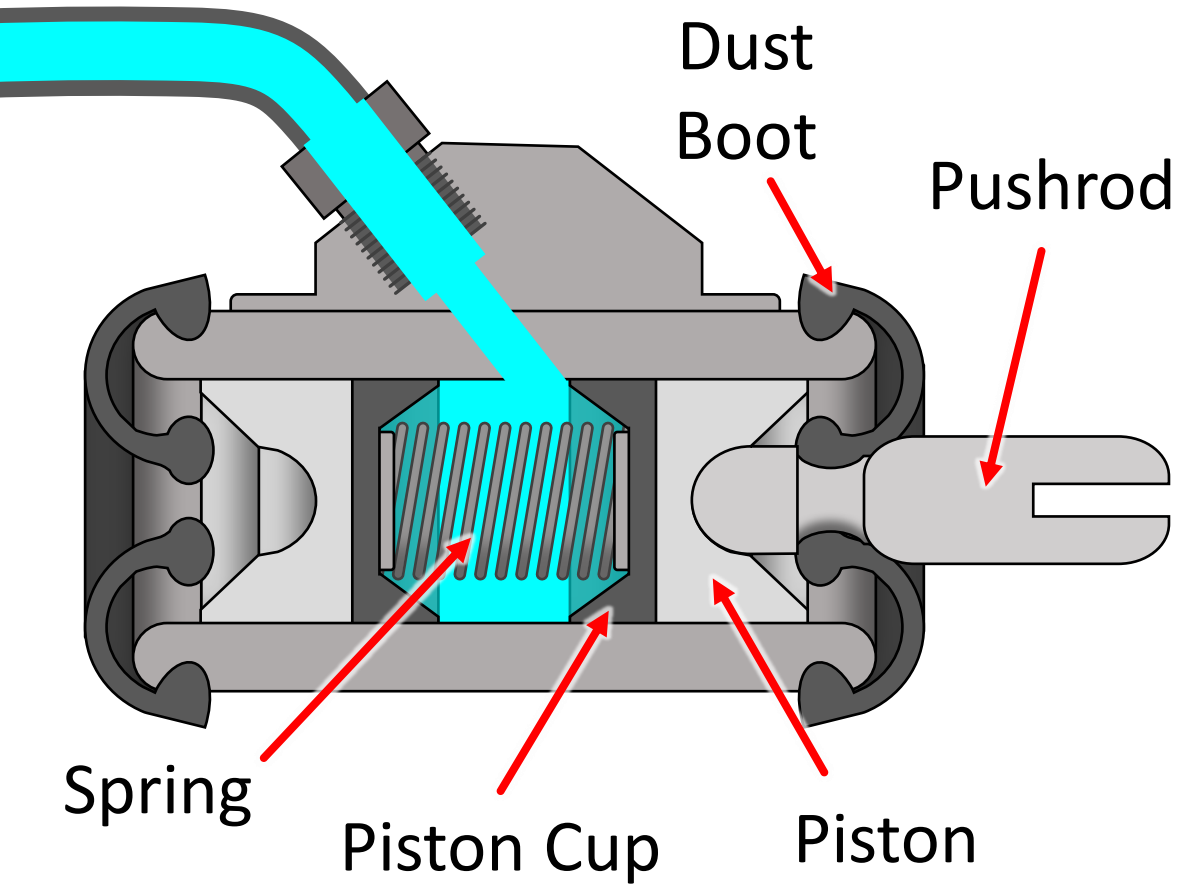
Brake System

Requirement 10b – Disc vs Drum Brakes

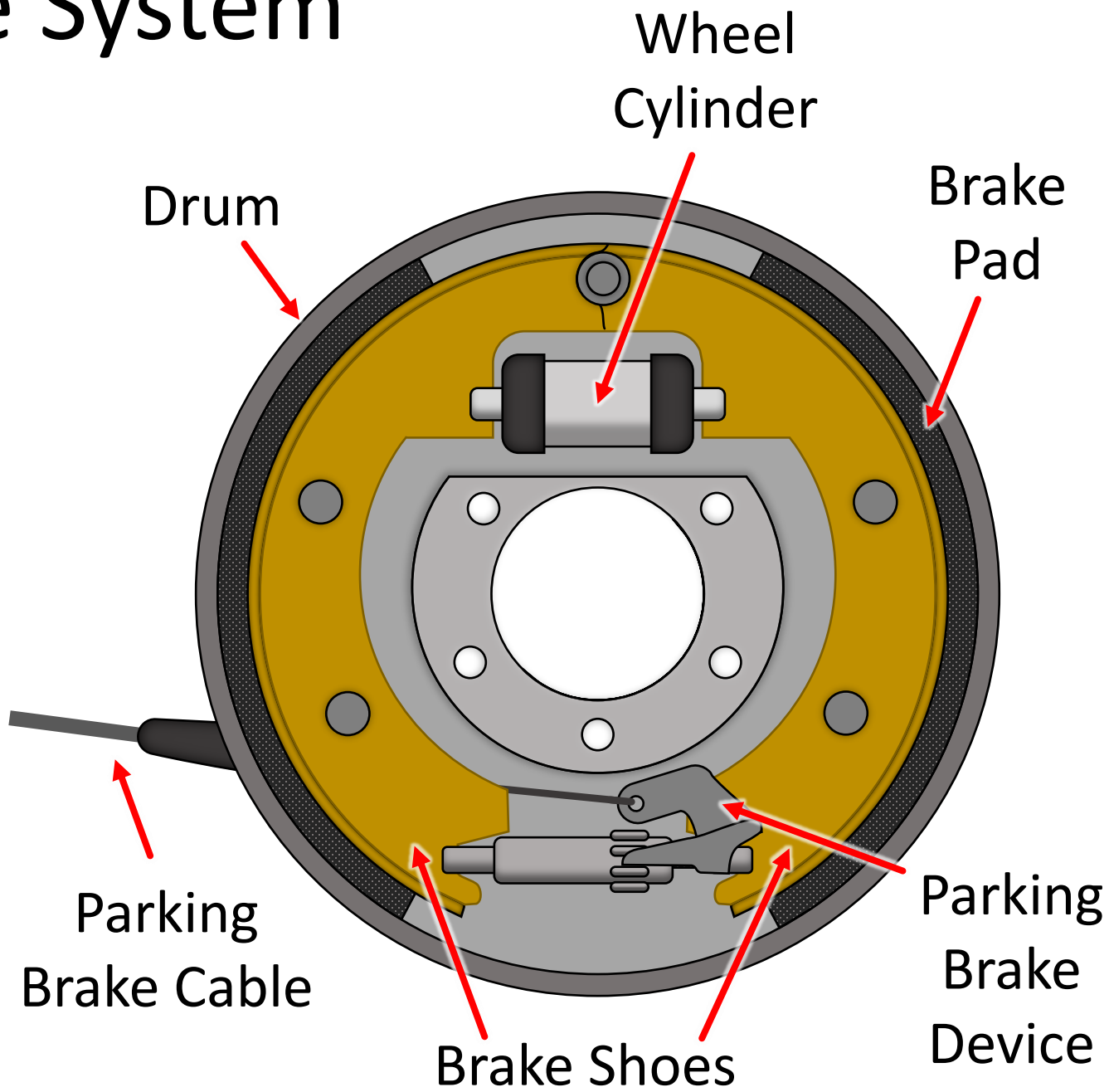
Explain the differences between disc and drum systems.

Brake System

Drum Brakes



Wheel Cylinder

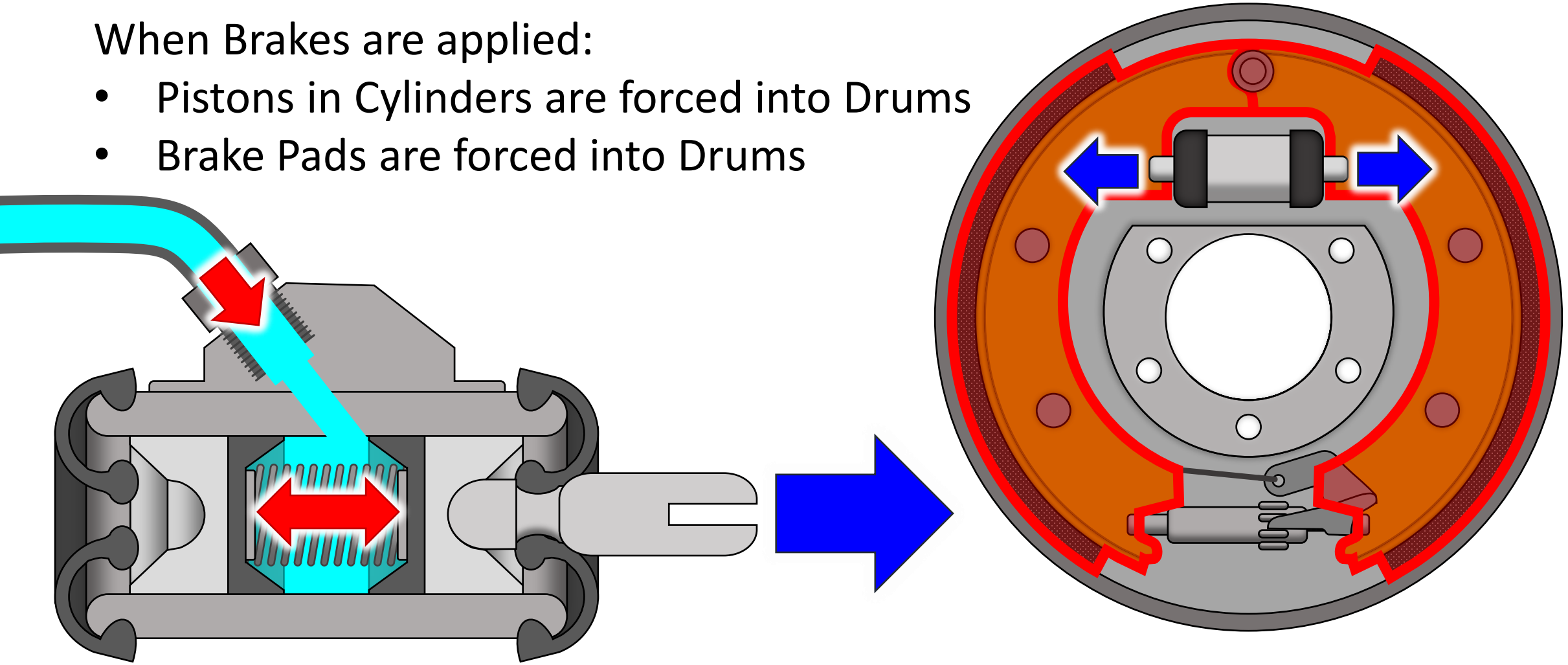


Brake System

Drum Brakes

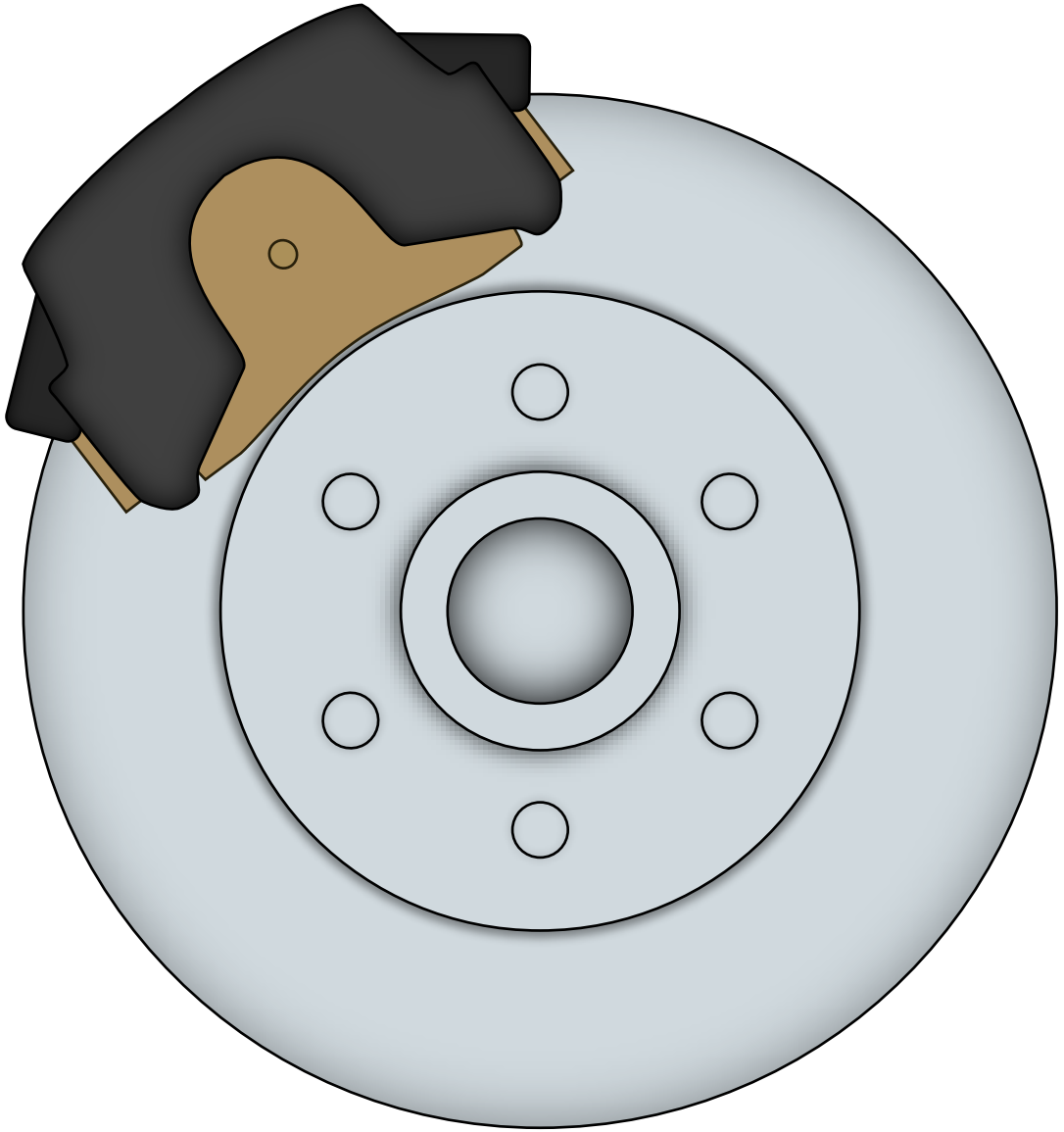
When Brakes are applied:

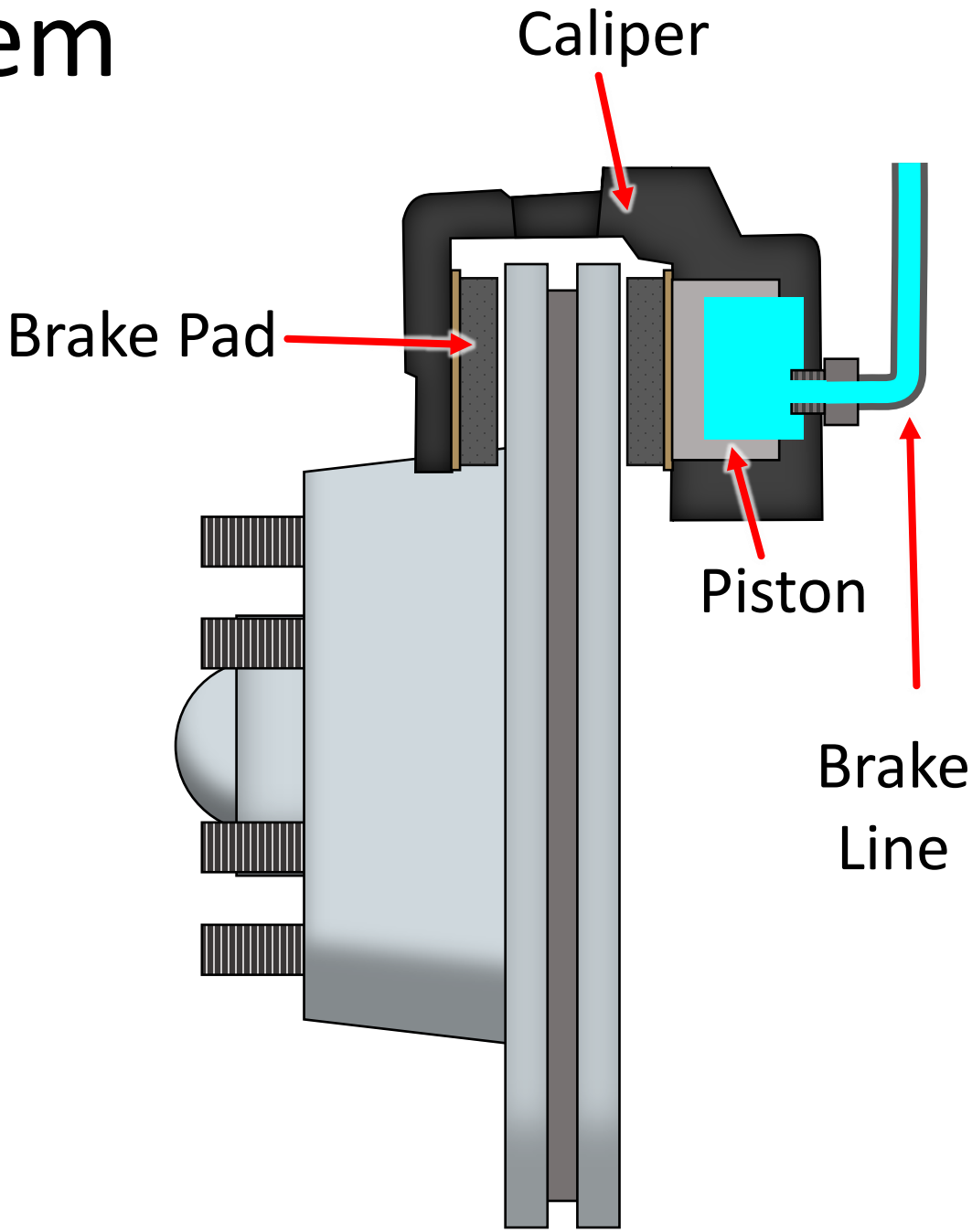
- Pistons in Cylinders are forced into Drums
- Brake Pads are forced into Drums



Brake System

Disc Brakes



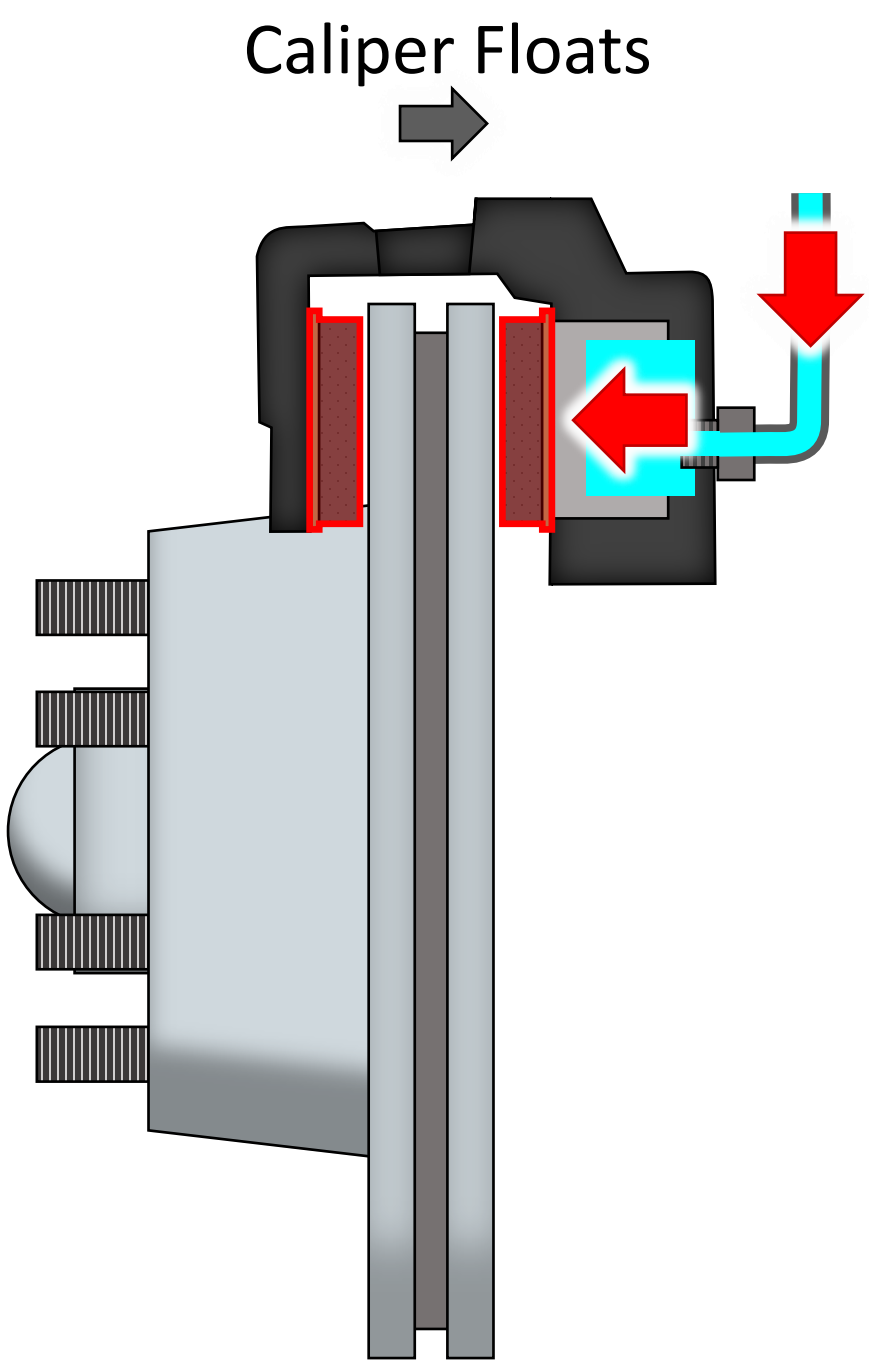


Brake System

Disc Brakes

When Brakes are applied:

- Pistons in Cylinders are forced into Pads
- Brake Pads are forced into Rotor
- Caliper “floats”
  - Equal pressure from inner AND outer Pads into Rotor



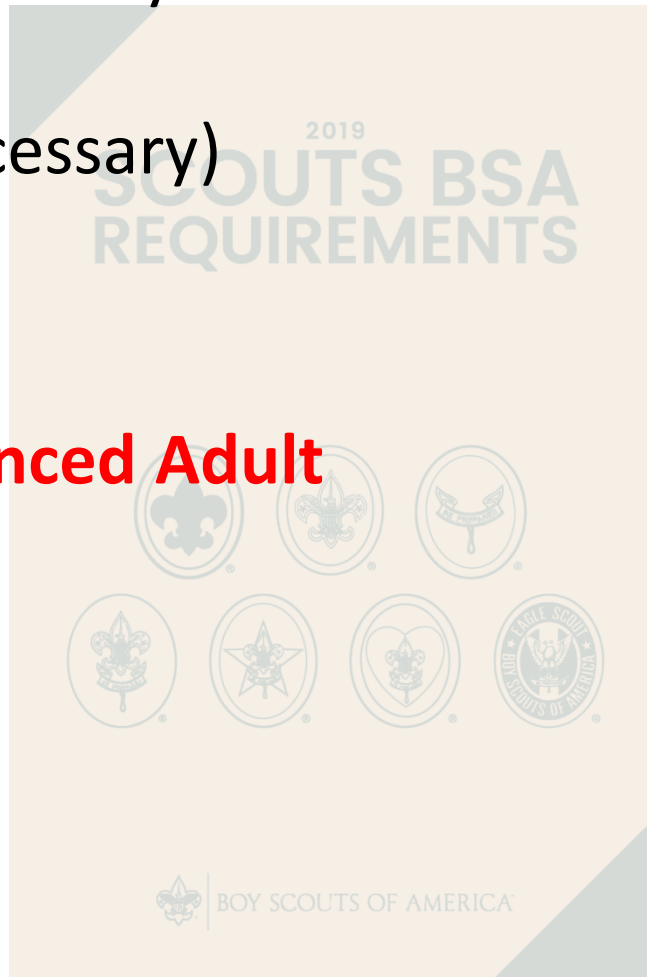
Brake System

Requirement 10c – Brake System Check

Demonstrate how to check the condition of a vehicle's brake system.

After checking, make recommendations for repairs (if necessary)

This requirement MUST be done with an experienced Adult



Brake System

Brake System Check

- Your brakes are the MOST important system in your vehicle
- The brake system gradually wears out over time
- Regular maintenance is VITAL to keep your vehicle safe

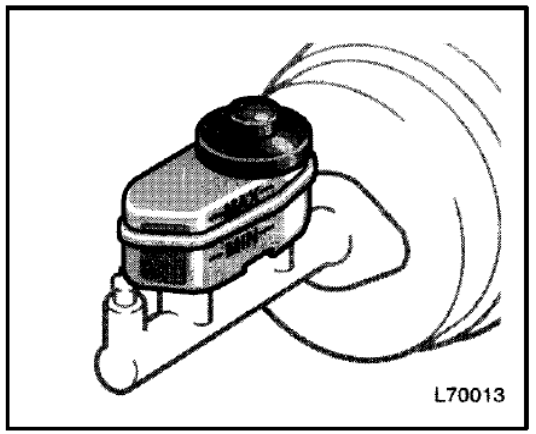
This requirement MUST be done with an experienced Adult

Brake System

Brake System Check – Brake Fluid

- Check Owner's Manual
  - Check proper levels
  - Use ONLY Fluid Type recommended by manufacturer
  - Use newly opened fluid
    - Brake fluid absorbs water
  - DO NOT overfill
  - Fluid is TOXIC!
  - If fluid very low, system may need to be bled

Checking brake fluid



To check the fluid level, simply look at the see through reservoir. The level should be between the "MAX" and "MIN" lines on the reservoir.

It is normal for the brake fluid level to go down slightly as the brake pads wear. So be sure to keep the reservoir filled.

If the reservoir needs frequent refilling, it may indicate a serious mechanical problem.

If the level is low, add SAE J1703 or FMVSS No. 116 DOT 3 brake fluid to the brake reservoir.

Remove and replace the reservoir cover by hand.

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Use only newly opened brake fluid. Once opened, brake fluid absorbs moisture from the air, and excess moisture can cause a dangerous loss of braking.

⚠ CAUTION

Take care when filling the reservoir because brake fluid can harm your eyes and damage painted surfaces. If fluid gets in your eyes, flush your eyes with clean water.

NOTICE

If you spill the fluid, be sure to wash it off with water to prevent it from damaging the parts or paint.

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Example of Owner's Manual

Brake System

Brake System Check – Brake Pads

- Inspect Brake Pads
  - Check Brake Pads every 15,000 miles
  - Is wear slot on pads visible? (or pad is at least 1/4” thick)
  - Is wear even?
    - Even wear on each pad
    - All Pads same thickness in front brakes
    - All Pads same thickness in back brakes

Brake System

Brake System Check – Rotors

- Follow your manufacture's recommendations on maintenance
  - Surface Condition
    - Burn Spots
    - Cracks
    - Unusually Deep Groves
  - Thickness
    - Minimum thickness should be stamped on edge of hub or rotor
    - Use a micrometer to measure thickness of rotor
    - Variation of thickness shoulder not exceed 0.001 inch
      - Can be corrected by turning the rotors

Brake System

Brake System Check

- Drive Test
  - Listen to brakes
    - Pads will squeal when worn down or worn out
  - Feel Brake Pedal and Steering Wheel
    - Vibrations may be sign of brake issues
    - Pulling to one side while braking may indicate brake issue
    - Is pedal squishy?
  - Warning Lights
    - Don’t ignore Brake Warning Lights
    - May indicate low brake fluid
    - May be something most significant
  - Does vehicle brake like it should?

Brake System

Brake System Check

www.youtube.com/watch?v=i2gy6QaRaXk

Brake System

Brake System Check

www.youtube.com/watch?v=ZpJc-KOFxF4

Automobile Knowhow

Automobile Knowhow

Requirement 11 – Do two of the following (a-c)

a. **Purchasing a Car**
b. **Cleaning a Car**
c. **Change a Tire**
d. **Oil and Filter Change**

Automobile Knowhow

Requirement 11a – Purchasing a Car

Determine the value of three different vehicles you are interested in purchasing.

One must be new and one must be used; the third vehicle can be new or used. For each vehicle, find out the requirements and cost of automobile insurance to include basic liability and options for collision, comprehensive, towing, and rental car.

Using the three vehicles you chose and with your merit badge counselor's assistance, complete the operation/maintenance chart provided in the merit badge pamphlet.

Use this information to determine the operating cost per mile for each vehicle, and discuss what you learn with your counselor.

Calculating Annual Totals to Produce Approximate Cost Per Mile

Expenses	New Car	Used Car	New or Used Car
Operating Costs			
Cost of gas per 10,000 miles driven			
(Cost per gallon of gas ÷ miles per gallon x 10,000)			
Maintenance			
Oil Changes			
Air, fuel filters			
Tune-ups			
Other			
Tires			
Rotation and Balance			
Wheel alignment			
Ownership Costs			
Insurance (Basic liability, collision, comprehensive, towing, rental car)			
License, registration, taxes			
Miscellaneous Costs			
Car washes, cleaning supplies			
Accessories			
Total Driving Costs (Add all rows)			
Divide total driving costs by total miles driven			
Yearly Cost Per Mile			

Note: If you will be financing your car, the monthly payment should also be figured in under ownership costs.

Automobile Knowhow

Requirement 11b – Clean a Car

Choose a car cleaner and wax product for a vehicle you want to clean.

Explain clear-coat paint and the precautions necessary for care.

Clean the vehicle, both inside and out, and wax the exterior.

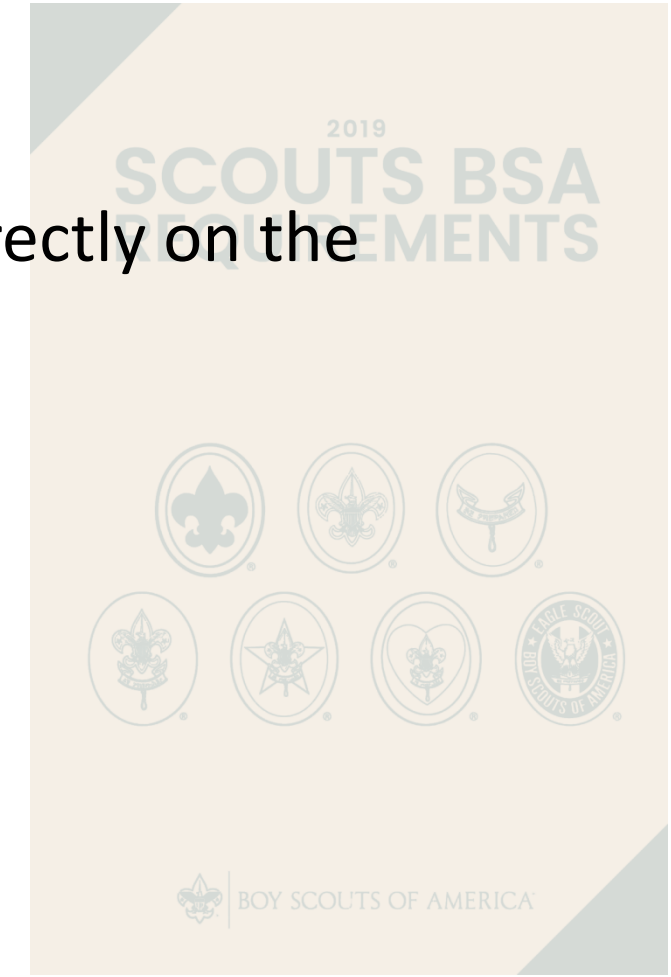
Use a vinyl and rubber protectant (on vinyl tops, rubber door seals, sidewalls, etc.) and explain the importance of the protectant.

Automobile Knowhow

Requirement 11c – Change a Tire

Locate the manufacturer's jack.

Use the jack to demonstrate how to engage the jack correctly on the vehicle, then change a tire correctly.



Automobile Knowhow

Safety

Caution: Never get under a vehicle supported only by a jack!

Jack stands or wheel chocks (if you are using a ramp) are recommended to help prevent wheels on the ground from rolling.

Be sure to use the jack provided by the manufacturer only in the manner specified by that carmaker and in the owner's manual.

The jack provided by the manufacturer is meant to be used ONLY when changing a tire.

Automobile Knowhow

Safety

This requirement MUST be done with an experienced Adult

Automobile Knowhow

Changing a Tire

Example of Owner's Manual

If you have a flat tire—

1. Reduce your speed gradually, keeping a straight line. Move cautiously off the road to a safe place well away from the traffic. Avoid stopping on the center divider of a highway. Park on a level spot with firm ground.
2. Stop the engine and turn on your emergency flashers.
3. Firmly set the parking brake and put the transmission in "P" (automatic) or reverse (manual).
4. Have everyone get out of the vehicle on the side away from traffic.
5. Read the following instructions thoroughly.

⚠ CAUTION

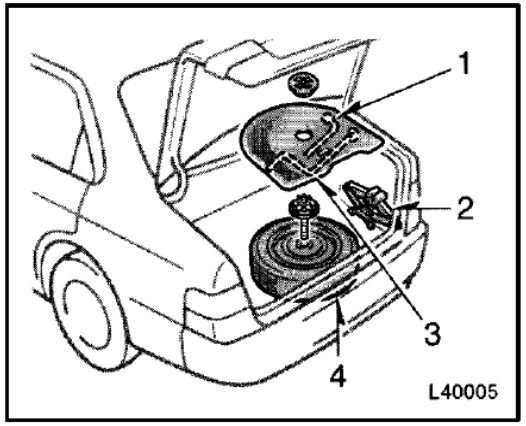
When jacking, be sure to observe the following to reduce the possibility of personal injury:

- **Follow jacking instructions.**
- **Do not start or run the engine while your vehicle is supported by the jack.**
- **Stop the vehilce at a level place and chock the wheel diagnonally opposite to the one being changed. Otherwise, the vehicle will move and possibly cause unexpected accident.**
- **Make sure to set the jack properly in the jack point. Raising the vehicle with jack improperly positioned will damage the vehicle or may allow the vehicle to fall off the jack and cause injury to the person.**
- **Never get under the vehicle when the vehicle is supported by the jack alone.**
- **Use the jack only for lifting your vehicle during wheel changing.**
- **Do not raise the vehicle with someone in the vehicle.**
- **When raising the vehicle, do not put an object on or under the jack.**

NOTICE

Do not continue driving with a deflated tire. Driving even a short distance can damage a tire beyond repair.

—Required tools and spare tire



1. **Get the required tools and spare tire.**
   1. Wheel nut wrench
   2. Jack
   3. Jack handle
   4. Spare tire

To prepare yourself for an emergency, you should familiarize yourself with the use of the jack, each of the tools and their storage locations.

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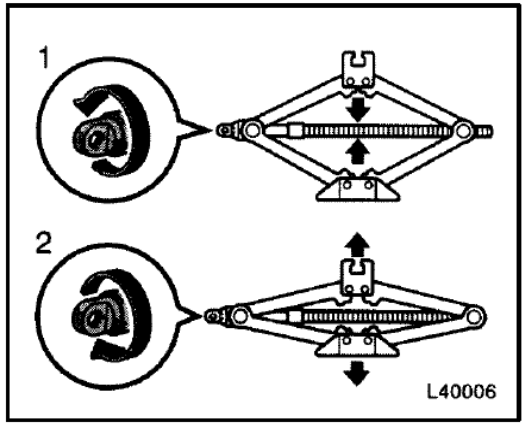
Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Changing a Tire

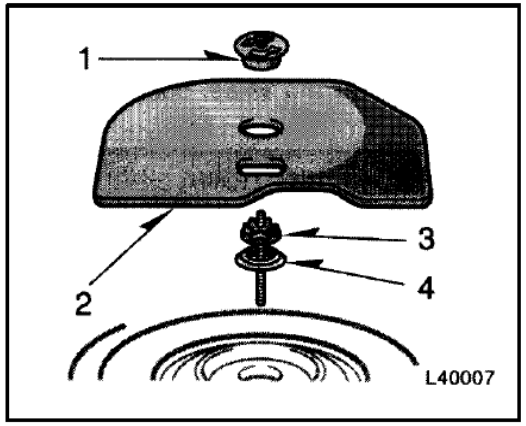
Example of Owner's Manual



Turn the jack joint by hand.

To remove: turn the joint in direction 1 until the jack is free.

To store: turn the joint in direction 2 until the jack is firmly secured to prevent it flying forward during a collision or sudden braking.



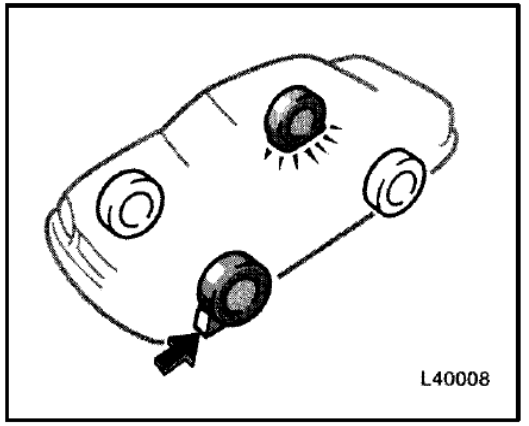
To remove the spare tire:

1. Loosen the nut and remove it.
2. Remove the spare tire cover.
3. Loosen the bolt and remove it.
4. Remove the spacer.

Then take the spare tire out of the vehicle.

When storing the spare tire, put it in place with the outer side of the wheel facing up. Then secure the tire by repeating the above removal steps in reverse order to prevent it from flying forward during a collision or sudden braking.

—Blocking the wheel



2. Block the wheel diagnoally opposite the flat tire to keep the vehicle from rolling when it is jacked up.

When blocking the wheel, place a wheel block from the front for the front wheels or from the rear for the rear wheels.

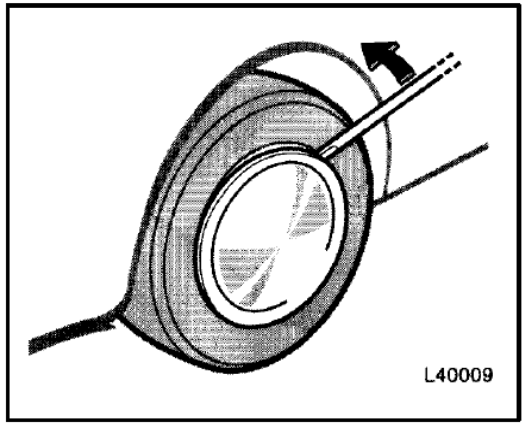
Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

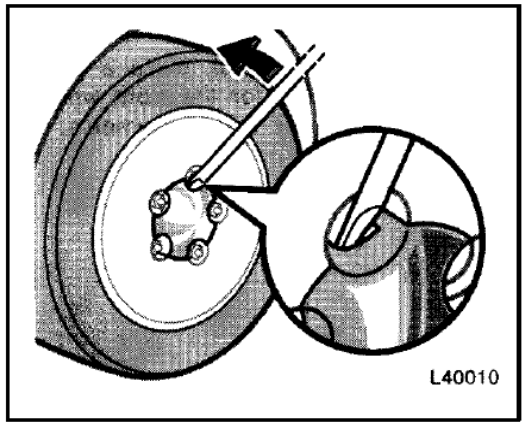
Changing a Tire

Example of Owner's Manual

—Removing wheel ornament



Steel wheels



Aluminum wheels

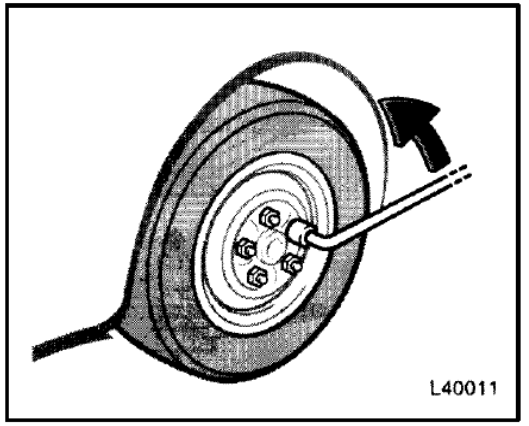
3. Remove the wheel ornament.

Pry off the wheel ornament, using the beveled end of the wheel nut wrench as shown.

CAUTION

Do not try to pull the ornament by hand. Take due care in handling the ornament to avoid unexpected personal injury.

—Loosening wheel nuts



4. Loosen all the wheel nuts.

Always loosen the wheel nuts before raising the vehicle.

The nuts turn counterclockwise to loosen. To get maximum leverage, fit the wrench to the nut so that the handle is on the right side, as shown above. Grab the wrench near the end of the handle and pull up on the handle. Be careful that the wrench does not slip off the nut.

Do not remove the nuts yet—just unscrew them about one-half turn.

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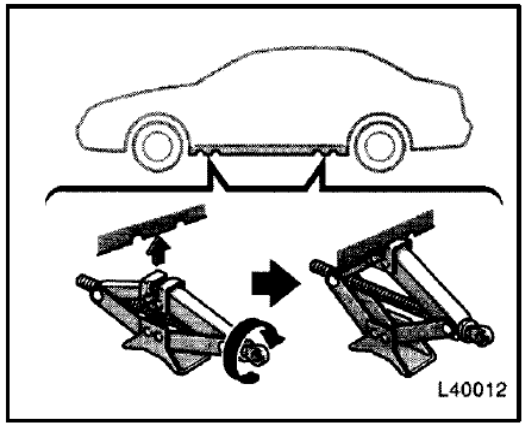
Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Changing a Tire

Example of Owner's Manual

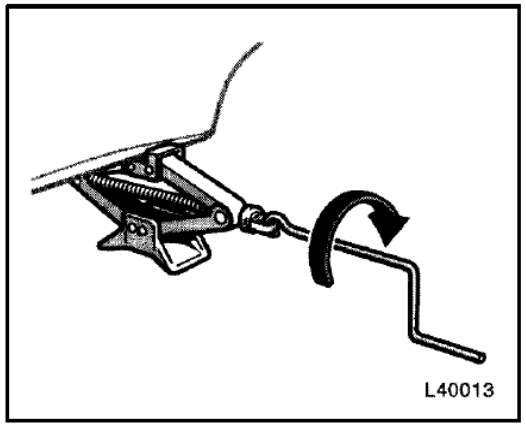
—Positioning the jack



5. Position the jack at the correct jack points as shown.

Make sure the jack is positioned on a level and solid place.

—Raising your vehicle



6. After making sure that no one is in the vehicle, raise it high enough so that the spare tire can be installed.

Remember you will need more ground clearance when putting in the spare tire than when removing the flat tire.

To raise the vehicle, insert the jack handle into the jack (it is a loose fit) and turn it clockwise. As the jack touches the vehicle and begins to lift, double-check that it is properly positioned.

⚠ CAUTION

Never get under the vehicle when the vehicle is supported by the jack alone.

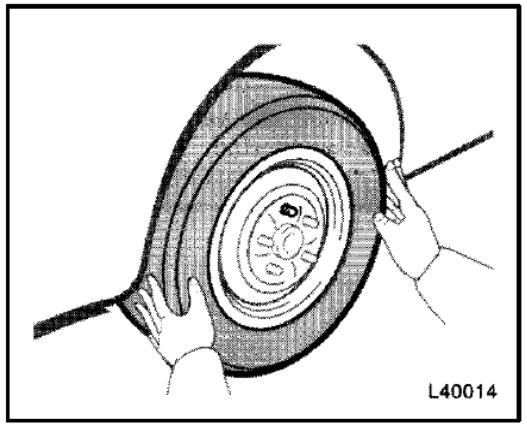
Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Changing a Tire

Example of Owner's Manual

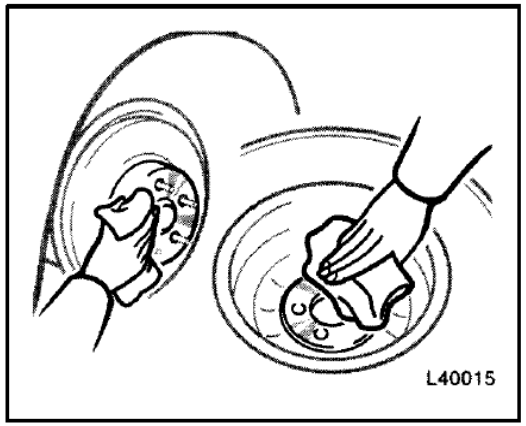
—Changing wheels



7. Remove the wheel nuts and change tires.

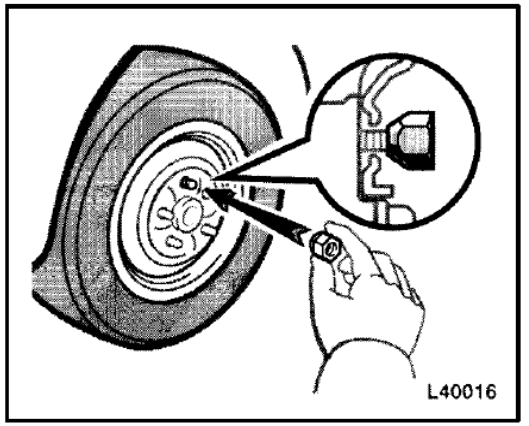
Lift the flat tire straight off and put it aside.

Roll the spare wheel into position and align the holes in the wheel with the bolts. Then lift up the wheel and get at least the top bolt started through its hole. Wiggle the tire and press it back over the other bolts.



Before putting on wheels, remove any corrosion on the mounting surfaces with a wire brush or such. Installation of wheels without good metal-to-metal contact at the mounting surface can cause wheel nuts to loosen and eventually cause a wheel to come off while driving. Therefore after the first 1600 km (1000 miles), check to see that the wheel nuts are tight.

—Reinstalling wheel nuts



8. Reinstall all the wheel nuts finger tight.

Reinstall the wheel nuts (tapered end inward) and tighten them as much as you can by hand. Press back on the tire back and see if you can tighten them more.

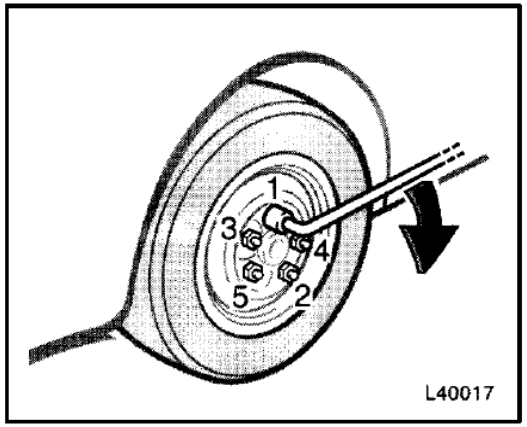
Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Changing a Tire

Example of Owner's Manual

—Lowering your vehicle



9. Lower the vehicle completely and tighten the wheel nuts.

Turn the jack handle counterclockwise to lower the vehicle.

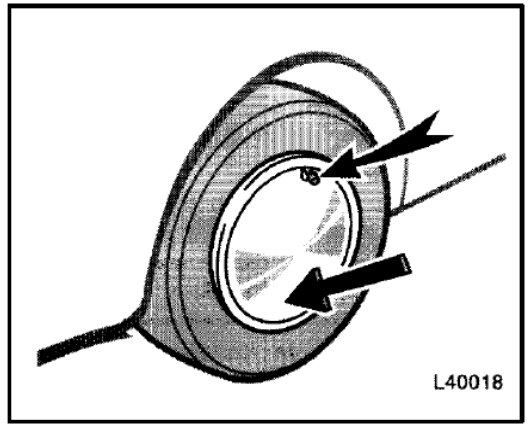
Use only the wheel nut wrench to tighten the nuts. Do not use other tools or any additional leverage other than your hands, such as a hammer, pipe or your foot. Make sure the wrench is securely engaged over the nut.

Tighten each nut a little a time in the order shown. Repeat the process until all the nuts are tight.

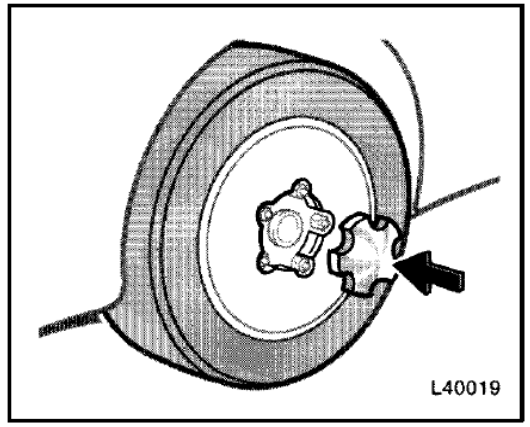
⚠ CAUTION

When lowering the vehicle, make sure all portions of your body and all other persons around will not be injured as the vehicle is lowered to the ground.

—Reinstalling wheel ornament



Steel wheels



Aluminum wheels

Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Changing a Tire

Example of Owner's Manual

10. Reinstall the wheel ornament.

1. Put the wheel ornament into position.

On some models, align the cutout of the wheel ornamant with the valve stem as shown.

2. Then tap it firmly with the side or heel of your hand to snap it into place.

CAUTION

Take due care in handling the ornament to avoid unexpected personal injury.

—After changing wheels

11. Check the air pressure of the replaced tire.

Adjust the air pressure to the specification designated in Part 8. If the pressure is lower, drive slowly to the nearest service station and fill to the correct pressure.

Do not forget to reinstall the tire inflation valve cap as dirt and moisture could get into the valve core and possibly cause air leakage. If the cap is missing, have a new one put on as soon as possible.

12. Restow all the tools, jack and flat tire securely.

As soon as possible after changing wheels, tighten the wheel nuts to the torque specified in Part 8 with a torque wrench, have a technician repair the flat tire and replace the spare tire with it.

CAUTION

Before driving, make sure all the tools, jack and flat tire are securely in place in their storage location to reduce the possibility of personal injury during a collision or sudden braking.

Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Changing a Tire

youtube.com/watch?v=joBmbh0AGSQ

Automobile Knowhow

Requirement 11d – Oil and Filter Change

Perform an oil filter and oil change on a vehicle.

Explain how to properly dispose of the used oil and filter.

Automobile Knowhow

Oil Change

- **Oil Change needs to be performed with an experienced adult**

- Equipment needed:
  - Proper quantity and type of oil
  - New oil filter
  - Drain pan
  - Tools to remove drainplug and filter
  - Funnel or other suitable tool for transferring oil
  - Towels for cleanup

Automobile Knowhow

Oil Change

ENGINE LUBRICATION

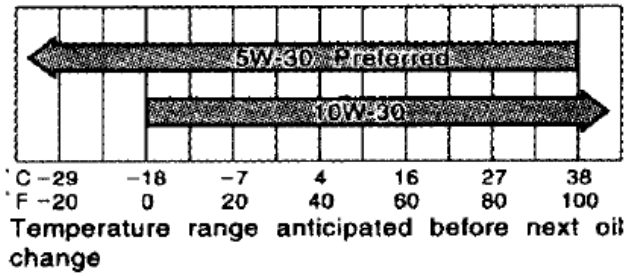
Oil capacity (drain and refill), L (qt., Imp. qt.):

5S-FE engine	
With filter	3.6 (3.8, 3.2)
Without filter	3.4 (3.6, 3.0)
1MZ-FE engine	
With filter	4.7 (5.0, 4.1)
Without filter	4.5 (4.8, 4.0)

Oil grade:

API SH, "Energy-Conserving II" multi-grade engine oil or ILSAC multigrade engine oil is recommended.

Recommended oil viscosity (SAE):



Temperature range anticipated before next oil change.

L70010

Images Source: 1997 Toyota Camry Owner's Manual

Automobile Knowhow

Oil Change

Step 1- Remove the oil fill cap and put it in a safe place.
Step 2- Side under the engine and position the oil drain pan directly underneath the engine pan plug.
Step 3- Use a wrench to loosen, then remove, the drain plug. (Remember to keep the oil drain pan underneath!) Oil will begin to drain immediately.
Step 4- Side out from under the car while the oil drains completely. The process takes several minutes, and you are safer out from under the vehicle than you would be underneath it.
Step 5- When the oil has completely stopped draining from the engine oil pan, return to your position under the car and replace the drain plug. Be sure to tighten the plug to prevent oil leaks when you add the new oil.
Step 6- Position the drain pan under the oil filter, then remove the filter by turning it counterclockwise. Carefully place the filter into the drain pan.
Step 7- Use a bit of new oil to coat the rubber gasket on the base of the new oil filter, then use your hands to screw the filter into place, about three-quarters of a turn after the gasket makes contact.
Step 8- Move the oil pan and filter out of the way. With an adult's assistance, reposition the jack under the car and jack the car back up so that you can remove the jack stands. Then slowly lower the car back to the ground. OR, if you used ramps, remove the chocks and have an adult roll the car back off of the ramps. Reset the parking brake.
Step 9- Add the recommended number of quarts of oil and replace the oil cap.
Step 10- Start the car and allow it to idle for about five minutes. The "check engine oil" light on the dash probably will remain lit until the new oil makes its way through the system.
Step 11- Check for leaks underneath the car. If oil is leaking onto the pavement, you will need to tighten the drain plug.
Step 12- Check the oil level. It should read "full:'

Automobile Knowhow

Oil Disposal

- Your local auto parts dealer will likely take your oil and filter
  - Generally free of charge
  - They use or recycle oil
- Do NOT dump oil in improper way!

Automobile Knowhow

Oil Change

youtube.com/watch?v=Nl0mFkpvAvM

Career Opportunities

Career Opportunities

Requirement 12 – Career Opportunities

Find out about three career opportunities in the automotive industry.

Pick one and find out about the education, training, and experience required for this profession.

Discuss this with your counselor, and explain why this profession might interest you.

Final Thoughts

Final Thoughts

Merit Badge Requirement Checklist

- ❑ Show completion of work
  Ideally - **Turn in complete Workbook**
- ❑ There are obviously requirements that must be done on a car
  Complete these can send confirmation of completion

If you are unable to fill out a Workbook
Please contact your councilor

Final Thoughts

Final Thoughts

Final Thoughts

Looking for More?

- Merit Badge Pamphlet is a great resource

Resources

Resources

Looking for More?

- Merit Badge Pamphlet is a great resource

Instructor’s Corner

Instructor’s Corner

Instructor’s Corner

- Thank you for teaching our scouts the Automotive Maintenance Merit Badge.

Instructor’s Corner

Instructor’s Corner - Thoughts

- This class is best done with a small group and in person
  - Small groups or one-on-one allow to you to safely teach
    Obviously, one-on-one instruction requires a second adult or scout

- A hybrid class with a mix of classroom and hands on is also great
  - Allows you to cover many of the basic requirements in class
  - Allows to demonstration and supervision of hands-on requirements

- A completely virtual course is possible, but only works if scouts have access to an adult with the proper skills to teach and supervise the scout

Instructor’s Corner

Resources

- prezi.com_automotive-maintenance-merit-badge-by-danny-burnsed
- scoutworks.weebly.com_auto_maintenance_mb_scoutworks_v2.pdf