

Lesson C6–4

Maintaining Small Engines

Unit C. Nursery, Landscaping, and Gardening

Problem Area 6. Using and Maintaining Tools and Equipment

Lesson 4. Maintaining Small Engines

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: III: Apply principles of service and repair to mechanical equipment, structures, biological systems, land treatment, power utilization, and technology.

Benchmark: III-A: Troubleshoot problems and evaluate performance to service and repair the components of internal combustion engines.

Performance Standard: 1. Describe principles of operation. 2. Identify engine systems and components. 3. Analyze and troubleshoot engine. 4. Perform overhaul procedures. 5. Evaluate engine performance through post-rebuild testing.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe equipment maintenance schedules.
2. Explain how to service intake/exhaust and fuel systems.
3. Discuss the maintenance of cooling and lubrication systems.
4. Discuss the servicing of compression and ignition systems.
5. Describe how to prepare equipment for storage.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Johnson, Donald M., et al. *Mechanical Technology in Agriculture*. Danville, Illinois: Interstate Publishers, Inc., 1998.

Other Resources. The following resources will be useful to students and teachers:

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals & Applications*, Fourth Edition. Albany, New York: Delmar Publishers, 2002.

Schroeder, Charles B., et al. *Introduction to Horticulture*, Third Edition. Danville, Illinois: Interstate Publishers, Inc., 2000.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Small engines
Cleaning supplies
Air compressor
Adjustable wrench
Spark plug wrench or socket set with spark plug socket
Point file
Spark plug gauges
Oil

Terms. The following terms are presented in this lesson (shown in bold italics):

Compression gauge
Dry-type air cleaner
Dynamometer
Fuel strainer
Hydrometer
Long-term storage
Maintenance interval
Multi meter (volt-ohm-amp meter)
Oil bath type air cleaner
Oiled foam type air cleaner
Preventative maintenance
Sediment bowl

Short-term storage
Spark tester
Thumb method

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Many pieces of horticultural equipment (mowers, shredders, edgers, chain saws, aerators, etc.) are powered by small engines. If the equipment is going to be helpful in doing efficient high quality work it is imperative the engines be properly maintained. Through this lesson, students will learn the basic maintenance needed to keep the engines running properly.

Summary of Content and Teaching Strategies

Objective I: Describe equipment maintenance schedules.

Anticipated Problem: When should small engine maintenance jobs be performed?

- I. The two fundamentals for managing small engines are to operate the equipment as it was designed to be operated and follow recommended maintenance procedures. **Preventative maintenance** is performing periodic practices to keep equipment in good working order. By performing preventative maintenance the owner tries to prevent costly repairs and downtime.
 - A. Clean air, fuel, and oil are keys to maintenance. Changing fluids, cleaning components, and replacing filters must be done on a regular basis. Consult the engine operations manual or service manual to develop a maintenance schedule.
 - B. Keep a written record of maintenance. **Maintenance interval** is the period between service jobs measured in either time (hours) or distance (miles). Cars use miles, but tractors and small engines use hours. Most manuals will divide maintenance into intervals of: daily before starting the engine, after the first 5 hours, every 25 hours, every 50 hours, every 100 hours, and every 500 hours. These intervals are established for normal operating conditions. If conditions are extremely dusty and dirty, the intervals recommended in the manual will be more often.

Use the TM: C6–4A and LS: C6–4A to show a sample maintenance schedule after having students help develop a definition of preventative maintenance. Stress the importance of proper maintenance to efficient operation and long life of the engine.

Objective 2: Explain how to service intake/exhaust and fuel systems.

Anticipated Problem: How can clean air and fuel be ensured for the engine?

- II. The intake/exhaust and fuel systems function to provide clean fresh air and fuel to the engine in the correct proportions and amounts, and remove burnt gases from the engine.
 - A. Fill the tank with clean fresh regular grade gasoline that has been stored and handled to properly. Fuel stored over 3 months deteriorates. Carburetor cleaner must be used to remove these deposits from a gas tank and carburetor. Any rubber or plastic parts must be removed before carburetor cleaner is used.
 - B. Engines equipped with a sediment bowl or fuel strainer should be checked and cleaned according to manufacturer's recommendations. The **sediment bowl** is a glass or metal bowl that allows particles (rust, metal, etc.) and water to settle out of the fuel. A **fuel strainer** is a screen that keeps particles from entering the carburetor.
 - C. Carburetor adjustments vary with the type of carburetor. Some small engines have factory preset non-adjustable carburetors.
 - D. To ensure clean air, the air cleaner should always be in place and properly serviced. A **dry-type air cleaner** contains no oil and is usually made of a paper type material. Cleaning involves tapping the element against a solid surface. Elements that cannot be cleaned must be replaced. The **oiled foam type air cleaner** uses a piece of foam with an oil film to attract dirt particles. Servicing involves cleaning the foam in solvent or detergent followed by drying and re-adding an oil film. The **oil bath air cleaner** uses a fibrous element along with an oil level to trap dirt particles. Servicing involves using solvent to rinse the bowl and element and re-adding oil to the recommended level.
 - E. Exhaust system maintenance involves replacing the muffler as needed. The muffler not only muffles noise but also helps carry heat away from the engine. Running an engine without a muffler is not a good idea.

Use TM: C6-4B to show fuel filters and air cleaners. Use LS: C6-4B to adjust a carburetor and LS: C6-4C to service an air cleaner.

Objective 3: Discuss the maintenance of cooling and lubrication systems.

Anticipated Problem: What maintenance does the cooling and lubrication system need?

- III. Cooling and lubrication are secondary functions. Air-fuel mixture, compression, and ignition (spark) are needed for any engine to start and are called primary functions. If the engine is to run for very long, cooling and lubrication are essential.
 - A. Small engines are either air or liquid cooled systems. The air system uses metal shrouds and plates to help direct the air from flywheel fins around the engine to carry away the heat. Keeping the engine clean is the most important service for this cooling system. Liquid cooled systems need to be checked periodically for leaks and the level needs to be monitored. A **hydrometer** is used to determine the freeze protection level of the coolant

by measuring the specific gravity or density of the coolant. Generally the coolant should be approximately 50 percent anti-freeze and 50 percent water.

- B. The lubrication system also helps carry away heat and reduces friction, which creates heat. If the lubrication system has an oil pressure gauge, monitor the pressure. Check the oil level prior to starting the engine. Follow oil change interval recommendations. Use the oil recommended for the time of year and conditions of use.

Discuss the importance of cooling and lubrication system maintenance to engine operation and engine life. Use LS: C6–4D to complete an oil change. The oil change could be a part of small engine storage preparation in Objective 5.

Objective 4: Discuss the servicing of compression and ignition systems.

Anticipated Problem: What maintenance needs to be done with the compression and ignition systems?

- IV. Compression and ignition systems are important to the efficient operation of equipment. Each system serves different purposes and has specific maintenance requirements.
 - A. The purpose of the compression system is to build up pressure in the cylinder so that when the air-fuel mixture is ignited the gases will expand and generate power to drive the piston down.
 - 1. A **compression gauge** will measure the compression in pounds per square inch (PSI). The compression reading will give an indication of the overall condition of the engine.
 - 2. The **thumb method** is a way of testing compression by taking the spark plug out and holding your thumb over the spark plug hole. When the engine is cranked over, the pressure should blow your thumb away from the spark plug hole.
 - 3. A **dynamometer** can be used to test engine horsepower. As the compression of an engine decreases with wear the horsepower output of the engine goes down.
 - 4. After 500 hours of operation, it may be recommended by the manufacturer re-torque the cylinder head bolts.
 - B. The purpose of the ignition system is to provide the spark for a spark ignition type internal combustion engine. Older style small engines still use a mechanical type breaker point ignition system. Breaker points and the condenser, along with the spark plug are replaced. Modern engines use a solid state or electronic ignition system. Solid-state ignition has greatly decreased the amount of preventative maintenance needed in the ignition system.
 - 1. A **spark tester** placed between the spark plug and the spark plug wire will test the presence of a spark as well as the strength of the spark.
 - 2. Keep the system clean.
 - 3. Check the condition of all wires and connections. A **multi meter (volt-ohm-amp meter)** can be used to check circuit continuity, resistance, voltage, and amperage.

4. For mechanical type ignition systems, follow manufacturer's recommendations for adjusting the point gap and replacing breaker points and the condenser. In the solid-state systems, the control module is often trouble-free for years. When the engine loses its spark, the module will need to be replaced.
5. With either system, clean, re-gap, and re-install with a new gasket or replace the spark plug at 100 hours or once a year.
6. If the engine has a battery ignition, monitor the battery. Clean the surface by using baking soda to neutralize the acid, keep the liquid level to the line, and use a battery hydrometer to test the state of charge. When the battery charge is low, use a battery charger. Hook red to positive and black to negative.

Discuss the importance of compression in analyzing the health of the engine. Demonstrate how to test compression. Show an example of a conventional and solid-state ignition system engine. Demonstrate spark testing, wire continuity testing, and battery maintenance. Use LS: C6–4E to service a spark plug or do it as a part of Objective 5 on preparing an engine for winter storage.

Objective 5: Describe how to prepare equipment for storage.

Anticipated Problem: What should be done to prepare an engine for storage?

- V. Storage can be short or long term. **Short-term storage** is defined as 30 days or less while **long term storage** is classified as more than 30 days.
 - A. Engines in short term storage should be stored in a dry inside place or if outside covered with plastic. Clean the engine, fill the fuel tank, and shut off the fuel line. Service the air cleaner and change the crankcase oil if necessary.
 - B. Engines in long term storage need to be cleaned and run until the fuel is burned. All filters should be serviced, the oil changed, the spark plug serviced or replaced, and the cylinder coated with oil. Coat exposed or unpainted surfaces with paint, grease or oil. If the engine is on a rotary lawnmower, sharpen and balance the blade. Store the engine in a clean dry place covered with a waterproof material such as plastic.

Use LS: C6–4F to prepare a lawnmower for winter storage.

Review/Summary. Use the transparencies and lab sheets to review and summarize the lesson. Stress with students that preventative maintenance saves time, breakdowns, and frustrations while extending the life of an engine.

Application. Preventative maintenance is applied by using the lab sheets with student owned engines.

Evaluation. The lab work and the written test will be used to evaluate mastery of the small engine maintenance lesson.

Answers to Sample Test:

Part One: Matching

1=g, 2=d, 3=h, 4=b, 5=a, 6=c, 7=f, 8=e, 9=j, 10=i

Part Two: Completion

1. air, liquid
2. muffler
3. thumb
4. compression gauge
5. dynamometer

Part Three: Short Answer

1. The written record lets you know when jobs were last done and when they need to be done again.
2. Long term storage: clean outside of the engine, run all the fuel out of the engine, clean or replace fuel filters, change crankcase oil, service spark plug, coat cylinder with oil, service air cleaner, service battery, coat exposed or unpainted surfaces with paint, grease, or oil, sharpen and balance mower blade, store in a clean dry place.

Test

Lesson C6–4: Maintaining Small Engines

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|-------------------------|-----------------------------|-----------------------|
| a. dry-type air cleaner | e. oil bath air cleaner | i. short term storage |
| b. fuel strainer | f. oiled foam air cleaner | j. spark tester |
| c. long term storage | g. preventative maintenance | |
| d. maintenance interval | h. sediment bowl | |

- _____ 1. Performing periodic practices to keep equipment operating efficiently.
- _____ 2. The period between service jobs measured in hours or miles.
- _____ 3. A glass or metal container that allows particles and water to be removed from fuel.
- _____ 4. A screen that keeps particles out of the fuel line.
- _____ 5. Air filter that contains no oil and is cleaned by tapping on a solid surface or with compressed air.
- _____ 6. Storing an engine for over 30 days.
- _____ 7. Air filter that uses a film of oil to trap dirt and dust.
- _____ 8. Air filter that uses an oil level with a fibrous filter to trap dirt and dust.
- _____ 9. Used to determine if the ignition system is working.
- _____ 10. Storing an engine for 30 days or less.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

- 1. Small engine cooling systems are either _____ or _____ cooled.
- 2. The exhaust system will be noisy and the engine will run hotter if the engine is operated without a _____.
- 3. Placing the thumb over the spark plug hole is called the _____ method of checking compression.

4. A _____ measures compression in pounds per square inch.
5. A _____ can be used to test engine horsepower.

Part Three: Short Answer

Instructions. Provide information to answer the following questions.

1. Why should you keep a written record of the maintenance done on a small engine?
2. List five jobs that are included in long-term storage preparation:

SMALL ENGINE MAINTENANCE SCHEDULE

Daily

- 1. Check oil level and add oil as needed.**
- 2. Clean external surfaces of engine.**
- 3. Check for and tighten any loose bolts or screws**

25 Hours

- 1. Change crankcase oil.**
- 2. Service air cleaner.**

100 Hours

- 1. Remove, clean, and re-gap the spark plug or replace with a new plug.**

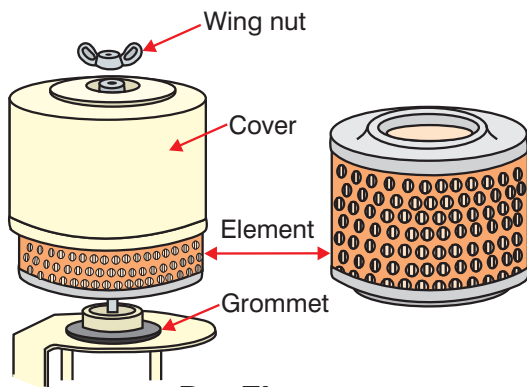
200 Hours

- 1. Check condition of breaker points, file, and re-gap or replace.**

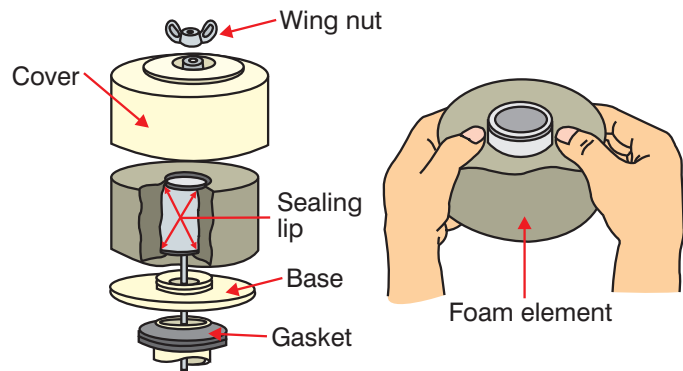
500 Hours

- 1. Check compression.**
- 2. Re-torque head bolts.**
- 3. Check the ignition system.**

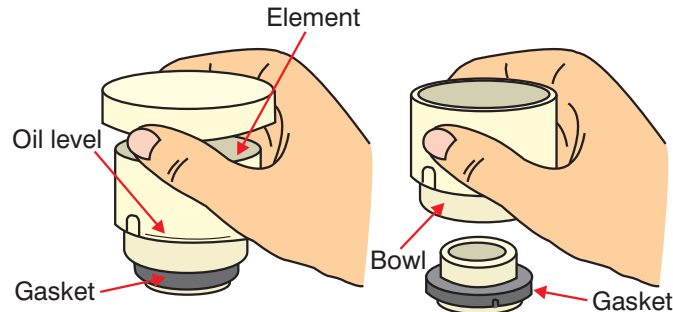
FUEL FILTERS AND AIR CLEANERS



Dry Element



Oil Foam



Oil Bath

(Courtesy, Interstate Publishers, Inc.)

Other Notes:

Match the recommended maintenance schedules. Use the service manual for your small engine.

- | | |
|-------------------------------------|--------------------|
| A. Daily before starting the engine | E. Every 100 hours |
| B. After the first 5 hours | F. Every 200 hours |
| C. Every 25 hours | G. Every 500 hours |
| D. Every 50 hours | |

- _____ 1. Check oil level and add as needed
- _____ 2. Fill with fuel
- _____ 3. Clear air intake screen
- _____ 4. Change oil in new or rebuilt engines
- _____ 5. Service air cleaner
- _____ 6. Change oil
- _____ 7. Clean cooling fins and external surfaces
- _____ 8. Check for and tighten any loose bolts or screws
- _____ 9. Check belt tensions
- _____ 10. Clean fuel filter
- _____ 12. Clean, re-gap, and replace the spark plug
- _____ 13. Check compression
- _____ 14. Re-torque cylinder head bolts
- _____ 15. Check compression
- _____ 16. Check the overall ignition system
- _____ 17. Check the condition of breaker points, file the points, and re-gap

Lab Sheet

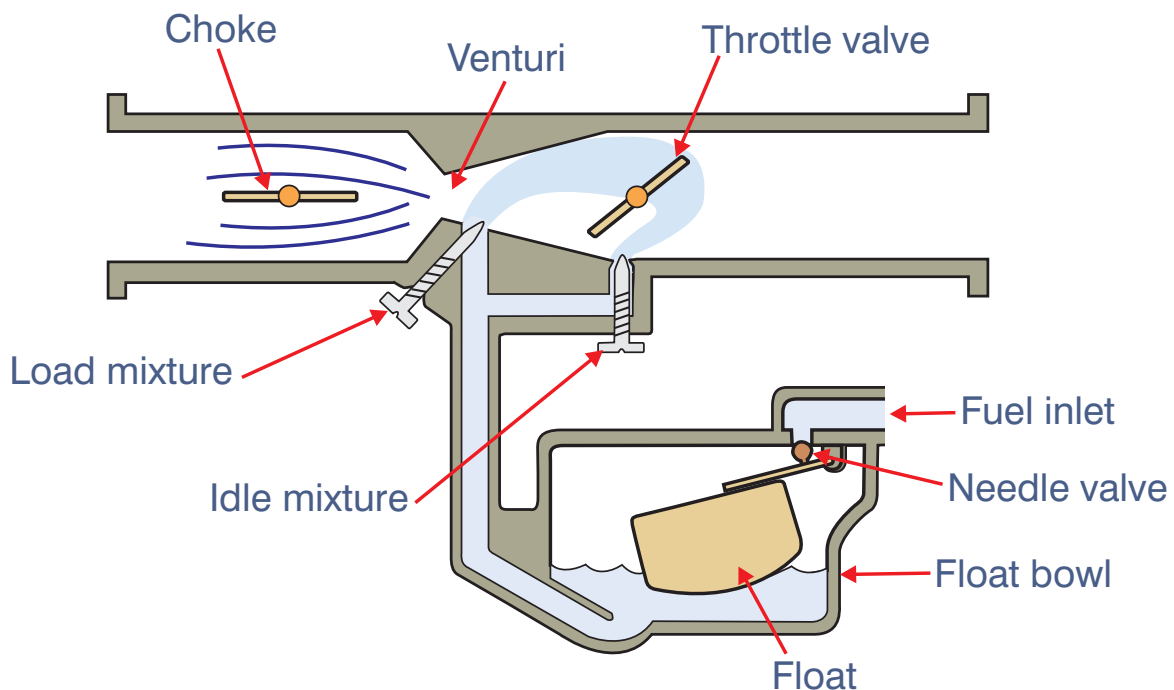
Carburetor Adjustment

Tools and Materials:

Small engine with a float-type carburetor
Operator's manual or service manual
Standard screwdriver
Small engine tachometer

Procedure:

1. Close the high-speed mixture valve and the idle mixture valve. Then, open the valves the number of turns recommended by the manual (called initial adjustment).
2. Check for an open gas tank cap vent and check tank for sufficient gas.
3. Be sure the gas line shut-off valve is on and the air cleaner is in place.
4. Start the engine and run it for 2 minutes to reach operating temperature.



5. Adjust the idle speed adjustment until the engine idles at the recommended speed as shown by the tachometer.
6. Throttle the engine to full speed.
7. Turn the high speed mixture valve until the engine runs rough, turn the valve back out until it runs rough again, and then find the midpoint between these positions as the final adjustment. Another approach is to use the tachometer. The final adjustment should be at the highest rpm for that particular throttle setting. Experienced mechanics can make the adjustment by listening to the sound of the engine.
8. If the engine has an idle mixture valve, set the speed at idle and use the same midpoint procedure described above.
9. As a last step, put the engine under load and check its performance. If the engine does not accelerate or pull well, turn the high-speed mixture valve slightly to enrich the mixture.

Note: If a suction-lift carburetor is used fill the fuel tank $\frac{1}{2}$ full. There will be no idle mixture adjustment.

Lab Sheet

Servicing Air Cleaners

Materials:

Air cleaner
Parts cleaning container
Cleaning solvent or kerosene
Old 2-inch paint brush
Rags or shop towels
40-watt light
Engine oil

Procedure:

1. Remove screw.
2. Remove air cleaner carefully to prevent dirt from entering carburetor.
3. Disassemble the air cleaner.
4. Oil Bath Type:
 - a. Dispose of old oil and sediment from bowl
 - b. Wash the bowl and element thoroughly in solvent and drain dry.
 - c. Clean bowl and refill with the same type of oil as used in the crankcase.
 - d. Reassemble the parts and fasten to the carburetor with the screw.
5. Oiled Foam Type:
 - a. Wash foam in kerosene or liquid detergent to remove dirt.
 - b. Wrap foam in a shop towel and squeeze dry.
 - c. Add several drops of engine oil to saturate the foam and squeeze to remove the excess oil.
 - d. Reassemble the parts and fasten the air cleaner to the carburetor with the screw.
6. Dry Element Type:
 - a. Place a lighted 40-watt bulb next to the center of the filter. If holes or tears are found or if a small amount of light shines through, discard the filter.

- b. Clean by tapping the element against a solid surface or by using compressed air blowing from the inside out. Use a maximum of 30 psi and keep the air nozzle at least 8 inches away from the filter.
- c. Reassemble the parts and fasten to the carburetor with the screw.

Lab Sheet

Changing Oil

Tools and Materials:

Small engine needing an oil change
Cleaning solvent and shop towel
Recommended oil
Adjustable wrench
Oil drain pan
Funnel

Procedure:

1. Run the engine 2 minutes to reach operating temperature.
2. Clean around the oil filler plug and the oil drain plug.
3. Position the drain pan under the drain plug and remove the plug.
4. Allow the oil to completely drain.
5. Replace the drain plug.
6. Remove the oil filler plug, insert the funnel, and fill the crankcase with the recommended amount of clean oil.
7. Clean any spills with the shop towels.
8. Clean the area and put away the materials, disposing of the used oil properly.

Lab Sheet

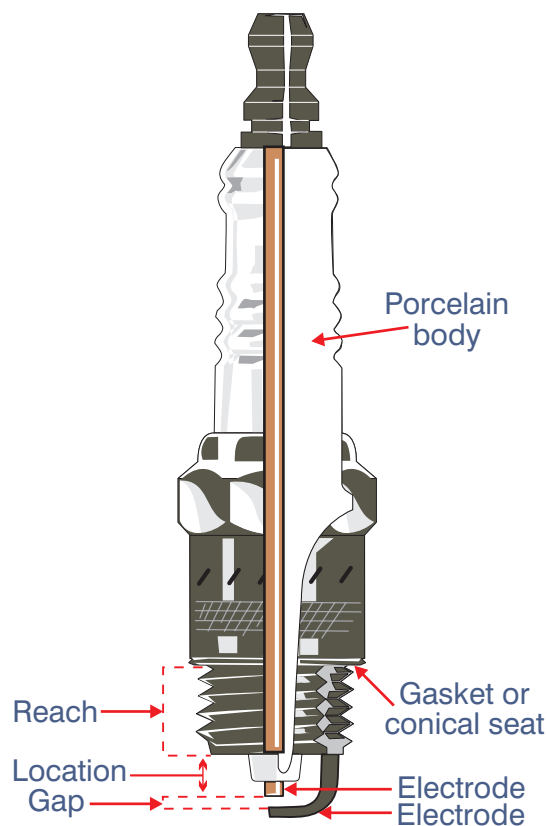
Servicing a Spark Plug

Tools and Materials:

Small Engine with a spark plug needing service
Spark plug gauge set
Socket set with spark plug socket
Torque wrench
Ignition file
Wire brush
Cleaning solvent
New spark plug gasket
Air compressor

Procedure:

1. Use the air compressor to clean particles around the spark plug.
2. Remove the plug from the engine using a spark plug socket.
3. Use solvent to clean oily deposits from the threaded portion of the spark plug.
4. Use the wire brush to clean carbon deposits from the plug.
5. Blow away all foreign material with compressed air.
6. Check the condition of the porcelain for cracks and breaks.
7. Use an ignition file to file the electrodes until the surfaces are flat.
8. Re-gap the plug using the correct size gauge.
9. Replace the plug gasket with a new gasket.
10. Re-install the plug to the recommended torque.



Note: Many mechanics recommend a new spark plug be installed instead of cleaning and re-gapping the existing plug.

Lab Sheet

Long Term Engine Storage Checklist

Complete this laboratory exercise for an engine, which is being prepared for long-term storage. Check each step as it is completed.

Make of Engine: _____ Model Number: _____

Serial Number _____ Cycle: 2 or 4

- _____ 1. Clean the outside of the engine.
- _____ 2. Start the engine to use all the fuel in the fuel tank, carburetor, and fuel line or fill completely adding a fuel stabilizer product to the fuel tank.
- _____ 3. Clean or replace fuel filters or strainers.
- _____ 4. Drain crankcase oil from the engine while it is still warm. Replace the drain plug and add fresh oil of the recommended viscosity to the proper level.
- _____ 5. Service oil filter if one is present.
- _____ 6. Remove spark plug and insert two tablespoons of SAE 10 crankcase oil in cylinder. Crank the engine several revolutions to distribute the oil. Stop the engine with the piston at the top position (TDC).
- _____ 7. Clean spark plug, regap, and replace with a new gasket or replace with a new spark plug.
- _____ 8. Service air cleaner.
- _____ 9. Clean battery surface with baking soda, add water to the line in the battery cells, and check the state of charge with a hydrometer.
- _____ 10. Coat exposed or unpainted surfaces with paint, grease, or oil.
- _____ 11. Sharpen and balance the blade if the engine that is being prepared for storage is a rotary lawnmower.
- _____ 12. Store the engine in a clean dry place covered with a waterproof material such as plastic.