



LEVEL
3

Tune It Up!



Small Engines Activities for Youth

Name _____

County _____



REVIEWED & RECOMMENDED
National 4-H Curriculum

Note to the Project Helper

Congratulations!

A young person has asked you to be a helper for Start Your Engines! This activity guide is for young people who want to learn about small engines. But they can't do it without you! You play a key role in helping them learn about small engines and about themselves. You can help through your enthusiasm and thought-provoking questions. With your help, they will set goals, find resources, and evaluate their own progress as they complete this level of Start Your Engines!

Start Your Engines! Project Activity Guides

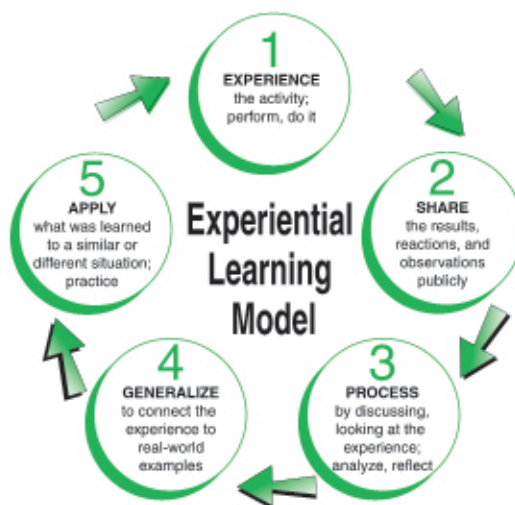
The small engines project is aimed at youth in grades 3–12. This is the second of three levels. Each activity guide features an achievement program for youth to complete.

1 – Crank It Up!	BU-08186
2 – Warm It Up!	BU-08187
3 – Tune It Up!	BU-08188
Helper's Guide	BU-08189

Start Your Engines! Helper's Guide

The Start Your Engines! Helper's Guide includes several group activities which you can adapt to family meetings, classrooms, and other youth settings. In the Helper's Guide you'll also find important information about life skills and youth characteristics and advice to help you with the youth guide activities.

Experiential Learning Model



Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals" © 1983 John Wiley & Sons, Inc. Reprinted with permission of John Wiley & Sons, Inc.

Experiential learning distinguishes 4-H youth development education from many formal education methods. Activities are designed so youth learn by first doing then reflecting on what they did and thinking about how they can apply it to other situations. In the question-and-answer section, called Cool Your Engines, you can help youth process the activity through each of these steps. Your aim as helper is to "guide" youth while they explore each activity.

Acknowledgments

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For more on small engines, look for these other guides in this set.



BU-08186

Level 1 - Crank It Up!

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A Slippery Subject
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Cool It!
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Let It Breathe!

Chapter 2: Working Well with Small Engines

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Closet Clues! What to Wear?
Lawn Ranger

Chapter 3: Making Small Engines Work for You

Learn to Earn
Wise Buys



BU-08187

Level 2 - Warm It Up!

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Make the Cut!

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BU-08189

Small Engines - Helper's Guide

Group Activities with Start Your Engines!

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Level 1 - Crank It Up!
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Small Engine Project Meeting Ideas

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Explore more at

www.4-hcurriculum.org

National 4-H Curriculum

Having Fun with *Tune It Up!*

Are you ready for some more challenges in Start Your Engines!? In this unit you will learn about tearing down and rebuilding an engine, using diagnostic tools, rules and regulations regarding small engines, selecting an engine, and potential small engine careers.

And you'll continue to learn more about yourself, too. You'll learn things you can use all your life, like planning and organizing, decision making, communication and marketable skills. Remember, continue to save all your notes, drawings and pictures in a Start Your Engines! Portfolio.

Your Project Helper

Do at least seven Start Your Engines! activities this year. There are 14 main activities in this project guide and several other fun activities in the Race Ahead sections.

You don't have to do all of this alone. Ask a parent, neighbor, or older friend to guide you in this project. Your helper can help you find the things you'll need for an activity. Your helper can also guide you as you talk about what you learned. When you're all done with an activity, your helper can check it off the list of activities in this guide.

*Write the name and phone number
of your project helper here*

My project helper

Phone

Address

Email



Inventory

**Tools and Supplies
You Will Need
for Activities in
*Tune It Up!***

- ☐ Box-end wrench set
- ☐ Calculator
- ☐ Compression tester
- ☐ Dial indicator
- ☐ Digital multimeter
- ☐ Feeler gauge, wire
- ☐ Flywheel holder
- ☐ Flywheel puller
- ☐ Hammer
- ☐ Lawnmower
- ☐ Micrometer
- ☐ Needle nose pliers
- ☐ Open-end wrench set
- ☐ Owner's manual
- ☐ Paper
- ☐ Pencil
- ☐ Piston ring compressor
- ☐ Piston ring expander
- ☐ Pliers
- ☐ Ruler or tape measurer
- ☐ Screw driver-blade
- ☐ Screw driver-Phillips
- ☐ Socket set
- ☐ Socket wrench-ratchet
- ☐ Spark plug socket
- ☐ Spark tester
- ☐ Starter clutch wrench
- ☐ Tang bender
- ☐ Torque wrench
- ☐ Vernier calipers
- ☐ Vibrating wire tachometer
- ☐ Valve spring compressor

**Good luck with Level 3
of Start Your Engines!**

Tune It Up! Planning Guide

Name _____

My Project Goals

Make a list of some of the things you plan to do in this project. Put this information in your portfolio.

Things I Plan to Do

Year 1

Year 2

Year 3

My Project Highlights

When you're done with Level 3, make a list of the things you actually did in the project. How does this list compare with your first list?

Things I Did

Before and After—What do you know?

Here is a great way to see if you learn something new and develop important skills in this project. Before you start doing the activities in this guide indicate what you know **NOW**. Then when you complete the Tune It Up! Achievement Program write down here what you know **AFTER**. You may be surprised to see what you learn! Share the results with your helper.

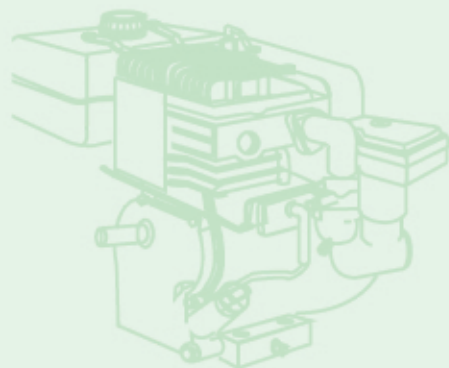
Begin each skill with the words **"I know how to..."**
Then circle **1** (to a great extent), **2** (somewhat) or **3** (not at all).

<i>I know how to ...</i>	Before	After
Match engine sounds to problems and adjustments	1 2 3	1 2 3
Identify and demonstrate diagnostic tools	1 2 3	1 2 3
Demonstrate how to tear down an engine's air and fuel system	1 2 3	1 2 3
Demonstrate how to assemble an engine's air and fuel system	1 2 3	1 2 3
Demonstrate how to tear down an engine's electrical system	1 2 3	1 2 3
Help someone assemble an engine's electrical system	1 2 3	1 2 3
Demonstrate how to tear down an engine base	1 2 3	1 2 3
Demonstrate how to assemble an engine base	1 2 3	1 2 3
Sharpen a lawnmower blade	1 2 3	1 2 3
Research information about small engine design	1 2 3	1 2 3
Research local small engine machine laws and regulations	1 2 3	1 2 3
Select a new small engine	1 2 3	1 2 3
Select the best machine for the money	1 2 3	1 2 3
Describe whether to start a small business	1 2 3	1 2 3

Tune It Up!

Achievement Program

Do at least seven activities each year. There are 14 main activities in this guide and many extra activities in the Race Ahead sections. You can also make up your own activities. Ask your project helper to initial each activity after you've done it.



Required Activities

Activities	Year Plan To Do	Date Completed	Helper's Initials
Chapter 1 - How Engines Work			
Motor Music I can identify small engine problems by sound.			
Advanced Tools I can identify and use diagnostic tools.			
Fuel and Air System – Coming Apart I can tear down the fuel and air system.			
Fuel and Air System – Coming Together I can reassemble the fuel and air system.			
Electrical System – Coming Apart I can tear down the electrical system.			
Electrical System – Coming Together I can rebuild the electrical system.			
Engine Base – Coming Apart I can tear down the engine base.			
Engine Base – Coming Together I can rebuild the engine base.			

Additional Activities

A. Race Ahead

Page: _____ Date: _____ Initial: _____

B. Race Ahead

Page: _____ Date: _____ Initial: _____

C. Write your own activity

Page: _____ Date: _____ Initial: _____

Chapter 2 - Working Well with Small Engines

Keep It Sharp! I can sharpen lawnmower blades.			
Know the Trends I can list the trends in small engine designs.			
Rules and Regulations I can list rules regarding small engines in my community.			
Selecting an Engine I can select a replacement engine.			

Additional Activities

A. Race Ahead

Page: _____ Date: _____ Initial: _____

B. Race Ahead

Page: _____ Date: _____ Initial: _____

C. Write your own activity

Page: _____ Date: _____ Initial: _____

Chapter 3 - Making Small Engines Work for You

Comparing and Purchasing I can purchase the best buy when looking for a machine with a small engine.			
Starting Your Own Business I can decide if I want to start my own business.			

Additional Activities

A. Race Ahead

Page: _____ Date: _____ Initial: _____

B. Race Ahead

Page: _____ Date: _____ Initial: _____

C. Write your own activity

Page: _____ Date: _____ Initial: _____

Tune It Up!



Completion Certificate

I certify that

has completed Level 3 - Tune It Up!
of the Start Your Engines! Small Engines Series.

Project Helper's Signature _____ Date _____



Photo of me and my project

Motor Music

Life Skill:	Problem solving
Small Engine Skill:	Identifying small engines by sound
Education Standards:	NS.9-12.1 – Science as Inquiry
Success Indicator:	Match engine sounds to problems and adjustments.
Toolbox:	Small tape recorder, tape

Warm Up!

Are you really in tune with small engines? Specific engines have very specific sounds. Someone who is really in tune with engines should be able to identify the differences in recordings. A properly tuned engine has a smooth sound and is working efficiently. An engine that isn't properly tuned will sound rough and will probably malfunction.

Throttle Up!

You are going to make adjustments to your engine, record them, and play them back later to see the number you recognize.

- With your mower standing on a flat surface like a driveway or sidewalk, make the following adjustments one at a time and record observations.
 - Close the choke half way.
 - Close the choke nearly all the way.
 - Hold the throttle valve closed against slow idle speed.
 - With the engine shut down, remove the muffler, then restart.
 - Simulate a dirty air cleaner by covering over half the air cleaner with part of a plastic bag.
 - With the engine shut down, loosen the spark plug one turn, then start the engine.
- Normal engine operation, no load, *i.e., lawnmower engine running, but not mowing.*
- Normal engine operation with load, *i.e., lawnmower mowing lawn.*
- Engine operation under large load, *i.e., tall grass.*



Recording engine sounds

Before recording the noise or sound, you may want to speak into the recorder identifying the sound. Listen to your recording; describe the effect each engine adjustment made on the sounds.

1. a

1. b

1. c

1. d

1. e

1. f

2.

3.

4.

Cool Your Engine

Share

- What did you hear?
- How did the sounds differ?

Process

- Why do engines have different sounds?
- When might it be important to be able to distinguish engine noises?

Generalize

- Why is it important to be able to recognize differences?
- Name some other times when you would need to use your sense of hearing to solve problems when working with other machines.

Apply

- How will listening help you solve problems in the future on other engine powered machines such as cars, trucks and construction machinery?

Race Ahead

1. Make recordings of engines from different machines, e.g., truck, car, and snow thrower. See if you can distinguish the noises.
2. Listen to engines operating in your neighborhood. Determine which ones are not properly tuned.

Manual Moment

Check your manual to see if it has any suggestions on using sound to determine what is wrong with an engine.

Stop

Pit Stop

Engine Sounds

Properly Tuned Engine

A properly tuned small engine has a smooth sound because it is using fuel efficiently. The fuel is burned completely with little or no unburned fuel in the exhaust gases to pollute the air.

Engine Sounds and Problems

The sound created by a malfunctioning engine frequently provides an indication of the engine's problem. Many experienced small engine repair people can determine an engine problem based on the sound it produces.

Dirty Air Cleaner

If the engine has a dirty air cleaner or the choke is partially closed, the air:fuel mixture is said to be "**rich**," which means there is an excess quantity of fuel entering the engine. The exhaust gases will then contain fuel that is not completely burned. This unburned fuel will be in the form of **hydrocarbons** and **carbon monoxide**. In an "**ideal**" fuel mixture, only water and carbon dioxide are components of exhaust.

Lean Mixture

An engine that is running with a lean mixture will run hotter than normal. Turning the carburetor needle valve in too far may create a lean mixture.

Other Sounds

A damaged muffler will create excessive noise, which may cause hearing loss for the machine operator and unhappy neighbors.

Operating the engine under different loads will change the sound because the governor is changing the throttle opening, trying to maintain engine speed. Therefore, with a large load the throttle is open more, but the engine is running at the same speed.

Caution Corner

- Block the wheels of the machine with blocks while making adjustments to the engine.
- After an engine has been operated, it will have some very hot parts. When you are making adjustments to those parts, you should do them right after the engine has been turned on, before the engine gets hot.

Advanced Tools



Using a piston ring expander

Life Skill:	Problem solving
Small Engine Skill:	Identifying and using diagnostic tools
Education Standards:	NS.9-12.2 – Physical Science
Success Indicator:	Identify and use diagnostic tools.
Toolbox:	Pencil, working small engine

Warm Up!

Tools are all around you, and many have specialized uses. In this activity, you will learn about diagnostic, or testing tools. These tools are used to test the condition or operation of an engine component or system. Different diagnostic tools can be used by a small engine technician to troubleshoot and repair a malfunction or failure.

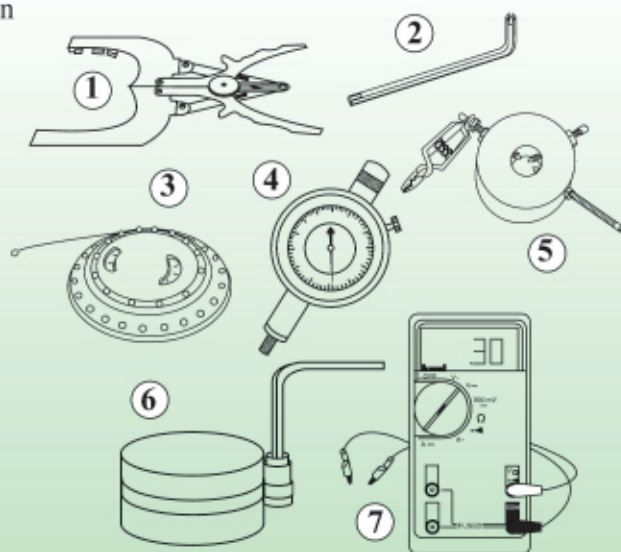
Throttle Up!

Match each tool listed below with its definition and picture at the left.

Letter No.

- _____ **Dial indicator**
- _____ **Digital multi meter**
- _____ **Spark tester**
- _____ **Vibrating wire tachometer**
- _____ **Piston ring compressor**
- _____ **Piston ring expander**
- _____ **Tang bender**

- A.** Adjust the engine idle speed.
- B.** Determine engine speed for single-cylinder engine.
- C.** Expand the piston rings for removal from the piston.
- D.** Compress piston ring for inserting piston into cylinder.
- E.** Measure change in position.
- F.** Measure two or more electrical values.
- G.** Test the condition of the ignition system.



Select one of the diagnostic or specialized tools above to use. You might try either a spark tester or the vibrating wire tachometer to start because these tools are low cost and available from most small engine repair shops.

The spark tester is used to determine the condition of the ignition system. When properly attached to the engine's electrical system, the spark will jump the tester's gap if operating properly. The first step is to adjust the tester's gap to manufacturer's specifications. In many cases it will be 0.166 inches. This can be done with a feeler gauge. Attach to the engine using the following steps:

- ☐ **1.** Remove spark plug wire from spark plug.
- ☐ **2.** Clip the tester to the spark plug terminal (tester should have an alligator clip).
- ☐ **3.** Connect the spark plug wire to the correct tester terminal.

Start the engine and observe if the spark is jumping the gap in the tester. If the spark jumps the gap, the electrical system is in good condition. If no spark occurs, you have electrical system problems.

The vibrating wire tachometer is used to determine the speed of single-cylinder engines. Rotating the dial on the tachometer changes the length of the wire extending from the tachometer. Its length determines the natural frequency at which the wire vibrates. The procedure for using it involves placing the tachometer on the operating engine, then adjusting the wire length until it vibrates a lot. You then read the tachometer dial, which will indicate speed in revolutions per minute. This is used to adjust the slow and fast engine idle speeds. You must obtain the slow and fast engine idle speeds from the engine manufacturer's specifications.

Procedure

1. Start the engine.
2. Set the back of the tachometer against some flat part of the engine.
3. Turn the dial of the tachometer, changing the wire's length until it has large vibrations.
4. Take the tachometer off the engine and read the engine speed.

Cool Your Engine

Share

- Describe what you did.
- Which tools did you use to test your small engine?

Process

- Why is it important to have specialty tools to help you troubleshoot engine problems?

Generalize

- What are some other times when you have used tools to help you solve problems?

Apply

- How can you use tools to help you solve problems in one of the careers you are considering in future employment?

Race Ahead

1. Visit a small engine repair shop to see the type of diagnostic tools in use.
2. Based on the information gained from your measurements, make engine adjustments to meet engine specifications.

Manual Moment

Check your manual for the diagnostic readings you should get from your small engine.

Stop

Pit Stop

Diagnostic Tools

Diagnostic tools provide information about the engine, which is very useful when trying to determine the cause of problems. They can also be used to provide information to make engine adjustments. Some tools are very low cost, such as the spark tester and the vibrating wire. These tools are needed if you are going to do engine repair on a large number of engines. Many manufacturers will have diagnostic tools very specific to their engines; therefore they may have part numbers.

- The dial indicator is used to measure change in position of engine parts.
- The digital multi meter can be used to test parts of the electrical system, specifically to check the continuity of the electrical coil. It can also be used to measure voltage, current and resistance.
- The piston ring compressor allows for easy installation of the piston into the cylinder. The rings are compressed into the piston grooves.
- The piston ring expander is used to remove and install piston rings on the pistons. The ring may need to be replaced or the piston ring grooves may need to be cleaned.
- The spark tester is used to check the condition of the ignition system.
- The tang bender is used to adjust the engine's idle speed by bending the wire linkage between the governor and throttle.
- The vibrating wire tachometer is used to determine engine speed for a single cylinder engine. Engine speed is determined by the vibration frequency of the wire.

Other advanced tools are used to remove deposits or metal from surfaces. Examples are grinding valves and valve seats, re-threading the spark plug hole, and honing the cylinder wall and resizing the cylinder base. Many of these tools may be very specific to a manufacturer's specifications.

Caution Corner

- Read the instructions before using the diagnostic tools.
- Be careful of points and places on the engine that can burn or scrape you.

Fuel and Air System

Coming Apart

Life Skill:	Marketable skills – make appropriate use of equipment, tools and technology
Small Engine Skill:	Tearing down an engine
Education Standards:	NS.9-12.2 – Physical Science.
Success Indicator:	Demonstrate how to tear down an engine's fuel and air system.
Toolbox:	Machine with a small engine, service manual, and tools (screwdrivers, wrenches, and specialty tools)

Warm Up!

Your body can go for many months without having any problems, but eventually you will have to go to a doctor to get a check-up to make sure everything is OK. It is the same for engines. Engines will operate many hours without problems, but eventually they also need a check-up or an overhauling.

Throttle Up!

Since there are many different small engine designs, this activity is not a detailed disassembling procedure. For that you will need a small engine service manual for your particular engine. Start with a clean surface to layout the parts in an organized pattern. One method is the order in which the parts

are removed from the engine. Label the parts as you remove them and make notes about parts that need to be replaced.

Record the following information about your engine and equipment:

Equipment type: _____
Equipment manufacturer: _____
Equipment model: _____
Engine manufacturer: _____
Engine model number: _____
Engine serial number: _____

Check each step as you complete it.

Preliminary Steps

- ___ Clean the outer surface of your engine before you start disassembling. If you can't wash the engine, wipe it clean with cloth rags.
- ___ Remove any fuel from the fuel tank and store it in a safety fuel can. If the gasoline is more than six months old, dispose of it properly.

Air and Fuel Systems

- ___ Remove the air cleaner and its cover (check the service manual for proper servicing).
- ___ Remove the fuel tank and connecting hose or pipe if separate from the carburetor.
- ___ Remove the carburetor and the fuel tank if it is attached.
- ___ Disconnect the choke and throttle linkage as necessary.
- ___ Separate the carburetor from the fuel tank.
- ___ Disassemble the carburetor.
 - ___ Inspect the throttle shaft and bushings for wear.
 - ___ Inspect any screens or fuel filters; clean if necessary.
 - ___ Check gaskets for wear.
 - ___ Clean carburetor parts, especially screens, with a carburetor cleaner.



Disassembly of a carburetor

List additional steps from service manual

Measurements (Fuel System)

Part name	Your observations	Manufacturer's specs
Needle valve (ex)	Ridged and bent	Smooth taper, straight

List of Parts to be Replaced

Part name	Part number	Number needed

Cool Your Engine

Share

- How did you start this activity?
- How did you label your parts?
- Describe the steps in disassembling the engine.
- What parts were worn or damaged?

Process

- What parts did you recognize?
- How did you decide what order to follow?
- How did you solve any problems that you had?
- How did you decide what parts were worn or damaged?

Generalize

- Name times when you have had to follow directions.
- How did you decide what parts needed to be replaced?

Apply

- Where else can you apply the skill of recognizing and replacing damaged parts?

Race Ahead

1. Disassemble another air and fuel system with a different type of carburetor.
2. Study the carburetor in an older automobile.
3. Obtain a new carburetor kit for the next activity.

Manual Moment

Consult your service manual when overhauling an engine.

Stop

Pit Stop

Carburetor Function

The carburetor mixes the air and fuel in the correct proportion, vaporizes the fuel, and delivers the proper quantity of the mixture.

Engine Needs

Rich air:fuel mixtures are needed for cold starting and slow idle. The choke or a small priming pump delivers the correct quantity for starting. The idle valve and internal passages deliver the correct quantity of the mixture for idle speed. During other operating conditions, the **needle valve** or **orifice** (small hole) maintains the air:fuel mixture.

Carburetor Operations

The valve or orifice meters the fuel quantity entering the air at the carburetor throat. The carburetor throat is also called a **venturi**. The venturi is a narrow area of airflow, which causes the air velocity to increase and the pressure to decrease. The lower pressure causes fuel to be drawn from the fuel tank or bowl. The fuel is brought through the valve or orifice and main nozzle. Here the fuel flows into the center of the venturi and mixes with the air. The mixture then flows past the throttle, through the intake valve, and into the cylinder.

Carburetor Kits

Often small engine companies provide carburetor kits that contain frequently replaced parts. These include screws, **gaskets**, and needle valves.



Caution Corner

- Use the correct tools for the job to minimize personal injury and damage to parts.
- If fuel spills when disassembling the carburetor, clean it up immediately.