



LEVEL

2

Warm 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

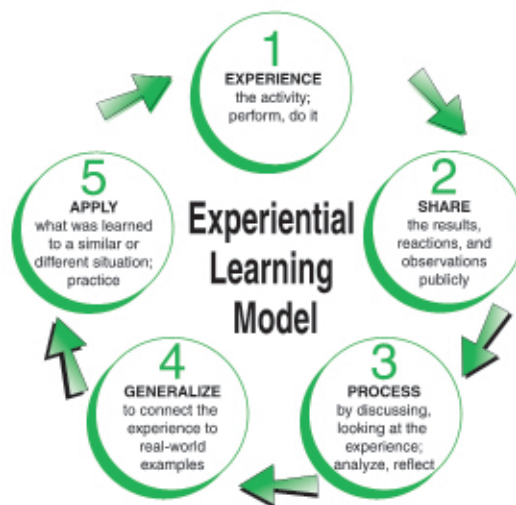
The small engines project is aimed at youth in grades 3–12. This is the second of three levels. Each activity guide features an achievement program for youth to complete.

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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Warm It Up! Table of Contents

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



BU-08186

Level 1 - Crank It Up!

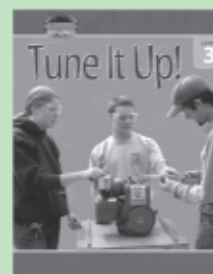
Chapter 1: How Engines Work
Parts Are Parts
Crank It Up!
Time for Tools
Parts, Parts, Everywhere Parts!
A Slippery Subject
Suck It Up!
Cool It!
Spark It Up!
Let It Breathe!

Chapter 2: Working Well with Small Engines

Keep It Labeled!
Closet Clues! What to Wear?
Lawn Ranger

Chapter 3: Making Small Engines Work for You

Learn to Earn
Wise Buys



BU-08188

Level 3 - Tune It Up!

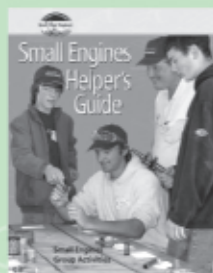
Chapter 1: How Engines Work
Motor Music
Advanced Tools
Fuel and Air System –
Coming Apart
Fuel and Air System –
Coming Together
Electrical System –
Coming Apart
Electrical System –
Coming Together
Engine Base – Coming Apart
Engine Base – Coming Together

Chapter 2: Working Well with Small Engines

Keep It Sharp!
Know the Trends
Rules and Regulations
Selecting an Engine

Chapter 3: Making Small Engines Work for You

Comparing and Purchasing
Starting Your Own Business



BU-08189

Small Engines - Helper's Guide

Group Activities with Start Your Engines!

Spark Up Group Activities
Tour Time
Skillathon
Small Engines Quiz Bowl
To Serve or Not to Serve?
Small Engine Bingo
Public Performance
Parts I.D.
Troubleshooting

Helpful Helper's Hints

Level 1 – Crank It Up!
Level 2 – Warm It Up!
Level 3 – Tune It Up!
Small Engine Project Meeting
Ideas

Note to the Project Helper Inside Front Cover

Table of Contents	1
Having Fun with Warm It Up!	2
Tools Inventory for Warm It Up!	2
Warm It Up! Planning Guide	3
Warm It Up! Achievement Program	4
Warm It Up! Completion Certificate	5

Chapter 1: How Engines Work

What's Your Type?	6
Name That Part!	8
Which Tool'll Do It?	10
Sizing Up!	12
Under Pressure	14
Mixing It Up!	16
Tearing It Down!	18

Chapter 2: Working Well with Small Engines

Seasoning Your Engine	22
Feel the Power!	24
Riding Safety	26
Make the Cut!	28

Chapter 3: Making Small Engines Work for You

Information Overload	30
Business Time?	32

Specs (Glossary) 34

More Fuel (Resources) 36



Explore more at

www.4-hcurriculum.org

National 4-H Curriculum

Having Fun with *Warm It Up!*

Are you ready for some more fun in small engines? In this level you will learn about different engine types, internal parts, specialized tools, engine size, compression, seasoning your engine, safety issues, starting your own business, and much more.

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

Your Project Helper

Try to do at least seven *Warm It Up!* activities each year. There are 13 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 learn. When you're all done with an activity, your helper can check it off the list of activities in this guide.

Write the name, address, phone number, and email of your project helper here.

My project helper

Address

Phone

email

Inventory

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

- ☐ Box-end wrench set
- ☐ Calculator
- ☐ Compression tester
- ☐ Hammer
- ☐ Feeler gauge, wire
- ☐ Flywheel holder
- ☐ Flywheel puller
- ☐ Lawnmower
- ☐ Owner's manual
- ☐ Micrometer
- ☐ Needle nose pliers
- ☐ Open-end wrench set
- ☐ Paper
- ☐ Pencil
- ☐ Pliers
- ☐ Ruler or tape measure
- ☐ Screw driver-blade
- ☐ Screw driver-Phillips
- ☐ Socket set
- ☐ Socket wrench-ratchet
- ☐ Spark plug socket
- ☐ Starter clutch wrench
- ☐ Torque wrench
- ☐ Valve spring compressor
- ☐ Vernier calipers

**Good luck with Level 2
of *Start Your Engines!***

Warm It Up! Planning Guide

Name _____

My Project Goals

Make a list or draw pictures of some of the exciting things you plan to do in this project. Put this information into your portfolio.

Things I Plan to Do

Year 1

Year 2

Year 3

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 Warm It Up!

Achievement program, write down here what you know **AFTER**. You may be surprised to see what you learned! 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
Classify types of engines	1 2 3	1 2 3
Identify internal small engine parts	1 2 3	1 2 3
Identify specialty tools	1 2 3	1 2 3
Calculate the size of an engine	1 2 3	1 2 3
Perform a compression test and compute compression ratio	1 2 3	1 2 3
Adjust a carburetor	1 2 3	1 2 3
Disassemble a small engine	1 2 3	1 2 3
Prepare a small engine for storage	1 2 3	1 2 3
Research the effects of changing sprockets	1 2 3	1 2 3
Determine the best direction to mow grass based on the center of gravity	1 2 3	1 2 3
Demonstrate how different cuts affect grass health	1 2 3	1 2 3
Select small engine parts wisely	1 2 3	1 2 3
Decide whether to start a small business	1 2 3	1 2 3

My Project Highlights

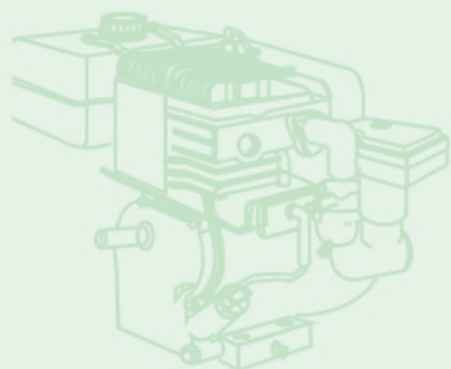
Make a list or draw pictures of the most exciting things you actually did. How does this list compare with your plan list?

Things I Did

Warm It Up!

Achievement Program

Do at least seven required activities each year. You can also make up your own activities. Ask your project helper to initial each activity after you've done it.



Required Activities

Activities	Date Completed	Helper's Initials
Chapter 1 - How Engines Work		
What's Your Type? I can classify small engine types.		
Name That Part! I can identify internal small engine parts.		
Which Tool'll Do It? I can identify specialty tools.		
Sizing Up! I can determine engine size.		
Under Pressure I can calculate compression ratios.		
Mixing It Up! I can make carburetor adjustments to create efficiency.		
Tearing It Down! I can follow procedures to tear down an engine.		

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

Seasoning Your Engine I can seasonalize my engine.		
Feel the Power! I can describe the effect of changing gears.		
Riding Safety I can find a machine's center of gravity.		
Make the Cut! I can identify reasons for sharp lawnmower blades.		

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

Information Overload I can decide which part is the best buy.		
Business Time? I can make a decision about starting 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: _____

Warm It Up!



Completion Certificate

I certify that

has completed Level 2 - Warm It Up!
of the Start Your Engines! Small Engines Series.

Project Helper's Signature _____ Date _____



Photo of me and my project

Chapter 1

How Engines Work

What's Your Type?



Science Skill: Classifying
Small Engine Skill: Classify small engine types
Education Standards: NS.5-8.1 – Science as Inquiry
Success Indicator: Classify types of engines.
Toolbox: Pencil, helper, small engine book or service manual

Warm Up!

Have you ever thought about how many machines use small engines? Think about all the things in the world that are powered by engines. Lawnmowers, snow throwers, and ATVs just to name a few. These engines have a lot in common, but they are not all alike. Small engines can be classified into many different categories, including the number of strokes and the orientation of the **crankshaft**.

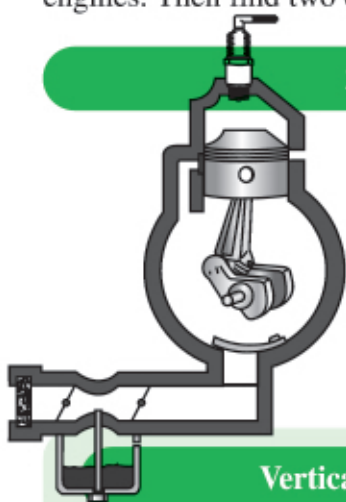


Comparing two different small engine machines.

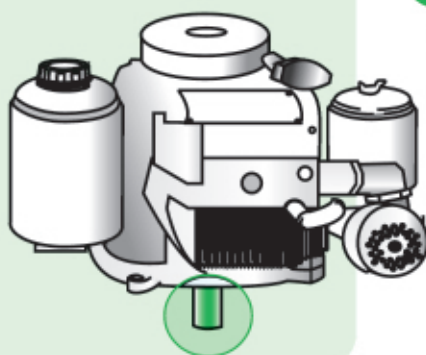
Throttle Up!

Look at the diagrams below and your small engine book or manual. Find two similarities and two differences for each of the following engines. Then find two examples of machines that use each type of engine.

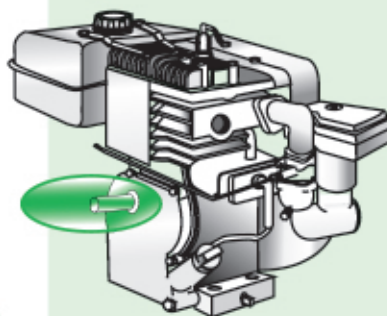
2-Stroke Cycle



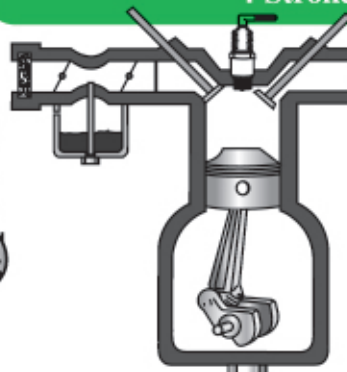
Vertical Crankshaft



Horizontal Crankshaft



4-Stroke Cycle



Cool Your Engine

Share

- How did you get started with this activity?
- Which engines were hardest to classify? Why?
- What kind of engines did you have?

Process

- Why is it important for you to know which type of engine you are using?

Generalize

- Why is it important to be able to classify things?

Apply

- When might you need to use your new classifying skills?

Race Ahead

1. Visit a small engine repair shop to check out all of the engine types in stock.
2. Surf the Internet or visit your local library for information on the engine types that interest you.
3. Check the engine types in your neighborhood.

Manual Moment

- Check the type of engine you have been using in this project.
- The owner's manual that comes with your engine covers the basics of small engine care, such as routine maintenance.
- For more specific engine care instructions consult a service manual, which should be available from your engine's manufacturer.

Stop

Pit Stop

Four-stroke vs. Two-stroke Cycle Engines

Small engines are internal combustion engines. That means they convert heat energy from the burning of a fuel inside the engine.

There are several differences between four-stroke cycle engines and two-stroke cycle engines.

Two-stroke

- One crankshaft revolution per cycle
- Engine oil is mixed with gasoline
- Usually doesn't have a **camshaft** or valves
- Air and fuel come in through ports
- **Exhaust** gases leave through ports
- Engine has less weight per **horsepower**
- Used more frequently on hand-held equipment
- Creates more **pollutants** in the exhaust gases

Four-stroke

- Two crankshaft revolutions per cycle
- Engine oil is in the crankcase
- Always has a camshaft
- Air and fuel come in through valves
- Exhaust gases leave through the valves
- Engines have more weight per horsepower
- Used more frequently on riding and walk-behind equipment
- Less pollutants than two-stroke

Equipment with vertical vs. horizontal crankshaft:

- Horizontal crankshaft
 - Riding lawnmower
 - Roto-tiller
 - Snow blower
 - ATVs
- Vertical crankshaft
 - Walk-behind lawnmowers

The heart of a small engine is the **piston** and the cylinder. A mixture of gasoline and air is drawn into the cylinder. This mixture is ignited by a spark from the spark plug. An engine cycle starts with air and fuel going into the cylinder. It ends when the exhaust gases are removed from the cylinder.

The cycle is divided into strokes. A stroke is the movement of the piston from one end of the cylinder to the other. The four-stroke cycle engine requires four strokes in this order: **intake**, **compression**, **power**, and **exhaust**. During each stroke, the crankshaft makes one-half revolution. For a complete cycle, the crankshaft turns two revolutions. On a two-stroke cycle engine, the crankshaft turns one revolution for a complete cycle. The two strokes are compression and power. Intake of the air and gasoline and the exhaust of the burned gases occur between power and compression.

Name That Part!



Life Skill: Locating and using resources
Small Engine Skill: Identifying internal small engine parts
Education Standards: NL-ENG.K-12.8 – Developing Research Skills
Success Indicator: Identify internal small engine parts.
Toolbox: Pencil, service manual, helper, an old small engine that can be torn apart, screwdriver, wrenches, specialty tools

Warm Up!

Ready to get to the nuts and bolts of a small engine, the internal parts that make the engine run?

Throttle Up!

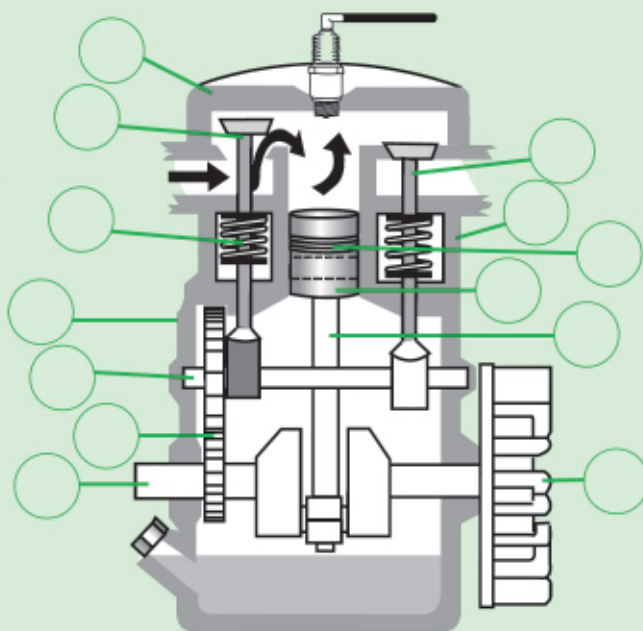
Using your service manual, find the internal parts listed below on your four-stroke cycle small engine. Check them off once you have found them. Match the parts at left with their definitions on the right. Match the parts to the letters on the diagram.

Educational boards are a great way to display parts.

Parts

- ___ Camshaft
- ___ Crankcase
- ___ Crankshaft
- ___ Connecting rod
- ___ Cylinder block
- ___ Cylinder head
- ___ Exhaust valve
- ___ Flywheel
- ___ Intake valve
- ___ Piston
- ___ Piston rings
- ___ Timing gear
- ___ Valve spring

- a. opens engine valves and includes cam gear, **cam lobes**, and bearing surfaces.
- b. valve through which burned gases are removed from the **combustion** chamber.
- c. spring that closes the valve.
- d. seals combustion chamber and wipes excess oil from the cylinder.
- e. houses and supports the crankshaft.
- f. drives the camshaft and keeps proper **synchronization**.
- g. transfers motion from the piston to the crankshaft.
- h. slides back and forth in the **cylinder bore** by forces produced in the combustion chamber.
- i. converts **linear motion** into **rotary motion**.
- j. fastened to the end of the cylinder block.



- k. contains cylinder **bore**, cooling fins, and valve train components.
- l. disc mounted at one end of the crankshaft to provide **inertia**.
- m. provides a path from the carburetor to the cylinder.

Cool Your Engine

Share

- What parts were easy to find? Hard to find?
- Which parts did you find in unexpected places?

Process

- What did you use to find the parts?
 - Why would you need to know where to locate the parts of an engine?
-
-
-

Generalize

- What are some times you used manuals to find out information?
-
-
-

Apply

- How can you use information sources in the future?
-
-
-



1. Look at other small engines and find the same parts.
2. Find other parts that you and your helper think are important.
3. Make a display of parts or pictures of parts and label them on a display board.
4. Make up some rhymes that will help you remember the parts of an engine.

Manual Moment

- Pick up free promotional pamphlets or posters from a small engine shop for pictures of engines.
- Contact your middle and high school education technology teacher for sources of information, such as small engine pamphlets, brochures and books.

Stop

Pit Stop

Internal Small Engine Parts

Piston and Cylinder

Engine parts convert the energy in gasoline to mechanical energy. In this case, the crankshaft rotation provides the mechanical energy or work from the engine. The cylinder encloses the space where the gasoline and air explode. One end of the cylinder is covered by the cylinder head. The piston provides the surface for the other end of the cylinder. The piston moves back and forth in the cylinder during engine operation. This changes the volume inside the cylinder. The cylinder head often provides the opening for the spark plug.

Piston and Crankshaft

The piston is connected to the connecting rod through the **piston pin**. The other end of the connecting rod is attached to the crankshaft. The primary function of the piston, connecting rod, and crankshaft is to convert back and forth motion to circular motion of the crankshaft. The piston rings create a seal between the piston and cylinder so there is no leakage of air or exhaust gases into the crankcase. The cylinder block is the main structure for the cylinder.

Timing

The camshaft is driven by the timing gears from the crankshaft and at one half the speed of the crankshaft on a four-stroke cycle engine. The camshaft has protrusions or bumps called cams or lobes. They open the intake and exhaust valves at the correct time. The valve springs hold the valves closed. The cam follower is located between the cams and valves.

Bearing and Flywheel

The crankcase is the base of the engine. It serves as the support for the **bearing** for the crankshaft and camshaft. It also serves as the engine oil reservoir. The massive flywheel is attached to the crankshaft. Its primary purpose is to keep the crankshaft turning between power strokes of the engine cycle and dampen peak firing forces/pulses.



Caution Corner

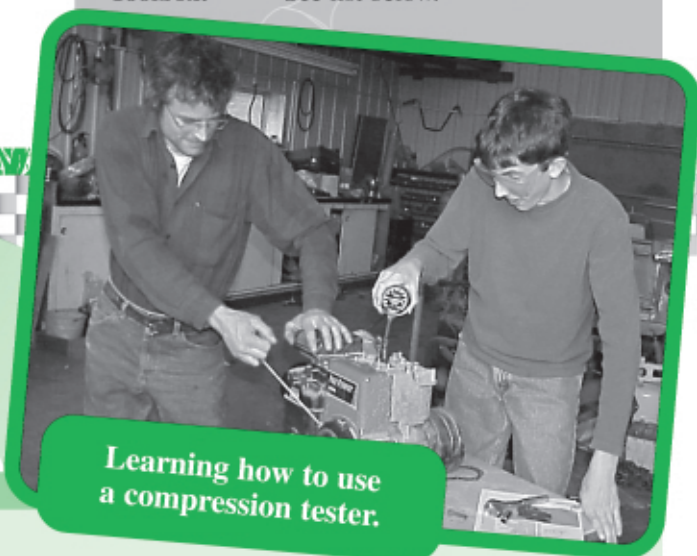
Be sure the engine is off during all observations.

Which Tool'll Do It?



Life Skill:	Locating resources
Small Engine Skill:	Identifying specialty tools
Education Standards:	NL-ENG.K-12.8 – Developing Research Skills
Success Indicator:	Identify specialty tools.
Toolbox:	See list below.

Warm Up! How many tools can you think of? Though tools are all around us, many have very specialized uses. You will learn about these specialty tools in this activity.

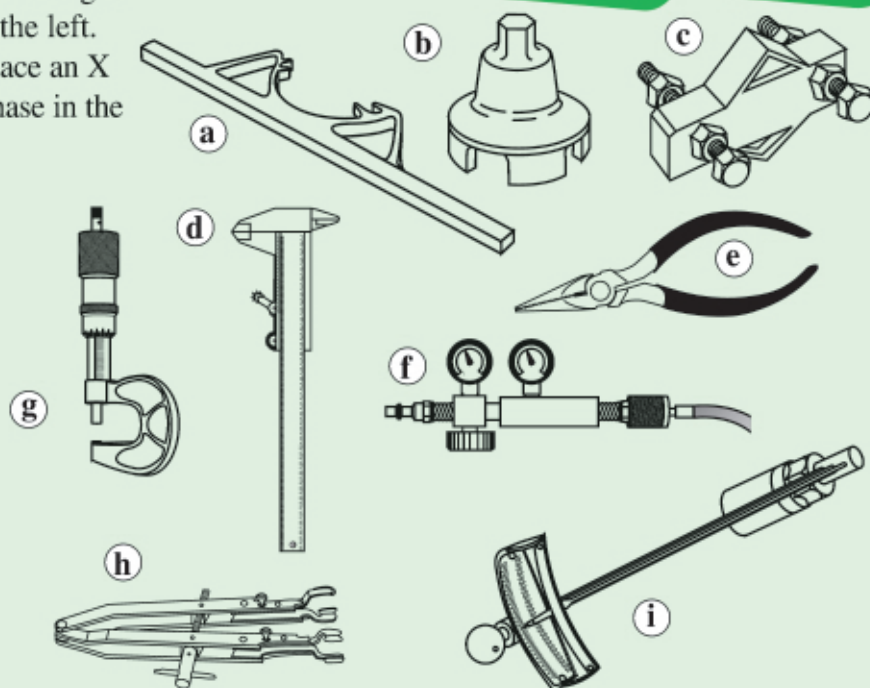


Learning how to use a compression tester.

Throttle Up! Match the tools pictured at right with their names on the left. Circle the tools to which you have access. Place an X by the ones you will need to borrow or purchase in the near future.

Tool Matching Game

- ___ Compression tester
- ___ Flywheel holder
- ___ Flywheel puller
- ___ Micrometer
- ___ Needle nose pliers
- ___ Starter clutch wrench
- ___ Torque wrench
- ___ Valve spring compressor
- ___ Vernier caliper



Find or borrow a torque wrench, then follow these instructions to practice using it.

Manufacturers often tell you how much you should tighten a bolt or nut on an engine or other machine. They do this to make sure the bolts or nuts do not turn loose and to meet the demands required by the engine parts. The engine head bolt is an example where the tightness or torque is specified. The most common torque wrench uses a socket. As the bolt is tightened with the torque wrench, you

will experience greater resistance in tightening the bolt. As this occurs the pointer on the wrench will move across a scale of numbers. When the pointer reaches the required torque or number, you should stop tightening.

For example the recommended torque for some head bolts is 140 inch-pounds. When you reach this torque with a wrench having a 14-inch handle, you will be applying 10 pounds on the handle at this point.

Cool Your Engine

Share

- What did you learn in this activity?
- What is the purpose of each tool?
- Which tools do you have and which do you still need?

Process

- Why is it important to have access to specialty tools when working on a small engine?
 - Where can you find information on how the unique names of these tools were derived?
-
-

Generalize

- What were other times when you have used resources, such as a small engine book?
-
-
-

Apply

- How can you use resources to find answers to questions in the future?
 - How comfortable are you that you can actually use all of the specialty tools you were able to identify?
-
-
-

Race Ahead

1. Visit a hardware store to study the many different types of specialty tools.
2. Visit a repair shop to see how the tools are organized.
3. Try to come up with new names for the specialty tools in this activity.
4. Interview a county 4-H agent or leader to discuss jargon used in the 4-H program.

Stop

Pit Stop

Tools for Working with Small Engines

- **Compression tester** is used to measure the buildup of pressure in the cylinder when the tester is placed over the spark plug hole and the crankshaft is slowly turned.
- Flywheel holder holds flywheel while removing or installing flywheel nut or rewind starter clutch.
- Flywheel puller is used to remove the flywheel.
- Micrometer is used to measure thickness and diameter.
- **Ring compressor** is used to compress piston rings for installation.
- Starter clutch wrench used to remove or torque a rewind starter clutch.
- Torque wrench used to tighten a bolt or nut to a specified torque.
- Valve spring compressor is used to compress valve springs for installation or removal.
- Vernier caliper is used to measure inside, outside and depth of parts.



Caution Corner

Don't forget your safety equipment (e.g., gloves and goggles).