

SMALL BUT MIGHTY MACHINES

The 4-H Ontario Small Engines Project



REFERENCE BOOK



THE 4-H PLEDGE

"I pledge:

My Head to clearer thinking

My Heart to greater loyalty

My Hands to larger service

My Health to better living

For my club, my community and my country."

THE 4-H MOTTO

Learn to do by doing

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Project Overview

With almost everything around us being motorized in some way, it's difficult to avoid using engines. However, many people have little to no understanding of how an engine works, let alone how to build or repair one. It is with this in mind that this project has been designed. Knowledge and understanding of small engines is not only essential to members interested in fields such as agriculture, engineering, mechanics and other trades, but to anyone looking to make smart and effective use of small engines present in every day life.

The study of small engines not only develops project specific skills, but also develops other personal life skills that can be applied to other projects and the everyday. This project is intended to foster an interest in, and a fascination with, how machine parts move and work together, which relates directly to Physics and Chemistry. Beyond this, deconstructing, designing and building small engines encourage the development of analytical and problem-solving skills. This type of project can also be an excellent opportunity for team-building and collaborative efforts among members, as well as a chance to venture out into the community and take advantage of resources right underneath their noses!

Learning about small engines also presents a unique opportunity to look to future developments. Engines have a long and fascinating history, and new models are being developed on a regular basis. An understanding of the fundamentals of small engines will help members to keep up, and make new technology work to their advantage. Related to this is the movement toward alternate fuel sources, the trend toward reusing and recycling equipment, as well as "smarter" use of engines. Members will not only learn about personal safety with small engines, but also ways in which the safety of the environment may be preserved.

Project Benefits to 4-H Members

Sensory - By observing, listening, touching and even smelling, members will gain understanding of how a small engine functions, as well as how to identify and repair malfunctions.

Motor - Small engine repair and construction enhance hand-eye coordination and spatial skills.

Mathematics, Physics and Chemistry - Members will calculate, measure, follow directions, and learn basic principals of movement, cause and effect.

Safety - Members will learn the importance of personal safety, the safety of others, and environmental hazards associated with small engines.

Social Skills - Members will learn to collaborate and cooperate with other members, their leaders, and their communities.

Emotional Development - Members will develop a sense of independence, accomplishment, and a positive self-image.

Content and Design

The 4-H Small Engines Project has been created for a leader, who already has a strong understanding of small engines, and how to work safely and effectively with them. It is recommended that the leader have a strong understanding and high comfort level with small engine mechanics and repair. If the leader does not possess the required knowledge, it is suggested the leader asks experts to assist with the content of the meetings. This project consists of two separate booklets for use by leaders and members: The Reference Book and Record Book.

The Reference Book

The Reference Book is laid out in meeting format, but there are four main sections in this project, which are designed to be completed in the order presented. Each section includes several topics based around common objectives. Due to time restraints, it isn't expected that all activities will be completed - select the reference material and activities that best fit with your schedule, as well as the interests of your members.

1. Taking Care: Small Engine Safety (Meeting 1)

This section contains activities and discussion topics that centre around basic safety procedures and considerations. It encourages members to take note of the equipment with which they work, and the workspace around them.

2. The Basics: All About Small Engines (Meeting 2)

This section provides an introduction to the basic parts and functions of small engines, while giving instructions concerning care, cleaning and storage.

3. A Closer Look (Meetings 3 & 4)

This section examines various systems within small engines, such as the cooling and air filtration.

4. Getting it Going (Meetings 5 & 6)

This section focuses on the actual running of a small engine, with reference to fuel and ignition components.

The Record Book – How and Why Members Should Use It

The Record Book should be given to each member at the first meeting. It includes charts and forms to help members track their progress and keep record of their accomplishments. Go through the book with members and explain the charts and forms. Encourage them to use the Record Book at each meeting, as it will be a great reference for them in both this project, and any other engine project. It should also include selected printouts from the Reference Book. When planning meetings, print out pages from the Reference Book that will be beneficial to your members. These pages should not replace, but accompany the Record Book. In essence they are creating/ compiling their own manual throughout the course of the project.



Pages labelled with a clover icon are suggested pages to distribute to members. This can be done either as a complete booklet at the beginning of the club or as smaller units at each meeting. Ask each member to bring in a binder to hold these pages and their Record Book.

Meeting 1

Have members fill-out “Club Information”, “Project Meeting Schedule” and “Project Goals”. This will ensure all members are informed and able to contact one another. Setting goals will not only highlight member interests, but will help make members aware of their accomplishments during the project.

Meeting 2

Have members fill out the “Owner’s Engine Information Form”. This will help members understand more about their projects, and what tools, supplies and equipment is needed. Members should also fill out the “Tool Inventory” sheet to keep track of their tools, and understand and appreciate the value they are responsible for. It is especially key when members are borrowing. Take a picture of each project engine, and have members paste their picture on their “Before and After” pages.

Meeting 3

The “Expense Record” should be filled out by each member as it’s not just tools that cost money! Members should keep track of what they spend on everything. Appreciating the total value of their finished project is important, as is tracking how much is spent. This record will encourage members to brainstorm ways to save money, and encourage money wise behaviours.

Meeting 4 & 5

Recap the resources used to date by members, and have each fill out the “Resources” page. This page will act as a reference sheet for members during the rest of the club and even later in life! Revisit and update the “Expense Record” and “Tool Inventory” sheets with members if applicable.

Meeting 6

Have members recap and reflect on the club and their project. Have each fill out “What I Have Learned: A Checklist” and the “Project Evaluation” sheet. If they are comfortable doing so ask members to hand in their “Project Evaluation” sheets. Their opinions will not only help you as a leader improve, but can also be passed on to 4-H Ontario to improve project resources written in the future. Take a picture of each completed project engine, for the members’ “Before and After” pages.

Activities

The 4-H Small Engines Project activities are designed to appeal to a variety of age groups and learning styles. Each activity is designed to be part of a series, progressing from a basic introduction to more complex, hands-on activities. Although the sections should be followed in sequence, the activities themselves may be done in any order suitable to the needs of members. Many of the activities contain suggestions to allow for variations which may be made according to the age group and interests of your members. To allow for time restrictions, you may select the activities that best reflect the interests and age levels of your members.

Each activity in the 4-H Small Engines Project has learning outcomes identified at the beginning of the activity, and important questions at the end. These are included to keep activities focused, and to encourage members to reflect on their experiences.

The activities were designed with two age groups in mind:

Junior: 10 to 14 years of age

Senior: 15 to 21 years of age

Each activity has been designed with accommodations for both age groups, but some are appropriate for one in particular. Learning outcomes are identified at the beginning of the activity, and important questions at the end.

Judging and Public Speaking Activities

Judging activities give the members an opportunity to use judging techniques as part of the learning process. Through judging, members learn to evaluate, make decisions and communicate with others. They also develop critical thinking skills, confidence and self-esteem.

Many of the activities involve a public speaking/ oral presentation portion. These activities help members develop confidence when speaking to their group and in public. These activities do not necessarily need to involve the topic of small engines, as the outcome should be more about understanding the concepts of effective communication rather than small engine information.

When planning meetings each should include either a judging or public speaking activity. The activity can even be part of the Roll Call or social recreation time after the engines have been put away. At least one judging or public speaking activity should be included in every meeting's agenda. However if you wish, feel free to create your own, or use an activity found in another project. For example, the 4-H Speak Pack, written by Alberta 4-H has many great public speaking activities.

Planning a Small Engines Meeting

Review available resources, plan the meetings and choose activities and worksheets that compliment the age groups, and interests of your members, as well as the practical parts of your work.

Each 4-H project must be held over a period of at least 4 separate meetings, totaling a minimum of 12 hours. Typically, 4-H meetings are approximately 120 minutes (2 hours) in length. Before each meeting, create a timeline to ensure an adequate amount of instructional time for club completion is provided.

Included in the following pages is a Leader's Planning Chart to help plan meetings. In addition to the chart, keep track of what went well, and what should be changed next time, because each time this project is taught, the content of the meetings can be different!

When planning each meeting, a typical 4-H meeting agenda should include the following:

- Welcome
- 4-H pledge
- Roll Call
- Secretary's Report
- Treasurer's Report (if any)
- Press Report
- New Business: Local and provincial 4-H activities/opportunities, upcoming club activities
- Meeting content and activities
- Clean-up
- Social recreation and/or refreshments
- Adjournment

Remember.... As a club volunteer your responsibilities are to:

- Complete the volunteer screening process and attend a volunteer training session
- Arrange a meeting schedule and participate in club meetings, activities and Achievement Program
- Have membership lists completed and submitted along with fees collected (if applicable) by the end of the second meeting
- Review project material in the Reference Book to familiarize yourself with the information and adapt it to fit your group. Be well organized, and teach the material based on your group's age, interest, and experience level.
- Have members fill out a Health and Safety Form and identify any health concerns such as allergies or respiratory difficulties. Where possible, make accommodations for these issues, such as allowing some members to observe, or complete portions of the project that will not interfere with their health. Ensure that all members, leaders and parent helpers know the appropriate actions during an emergency. Important: Ensure you have the members' Health and Safety Forms at each meeting.

Club member responsibilities are to:

- Participate in at least 2/3 of his/her own club meeting time.
- Complete the project requirements to the satisfaction of the club leaders
- Take part in the project Achievement Program

Leader's Planning Chart

Mtg. #	Date/Place	Topics Covered	Activities	Materials Needed

Field Trip and Tour Ideas

If there are time and resources available, a trip into the community is an excellent way to introduce members to the resources available to them. It can also give members an idea of what it is like to work on small engines as a career. They may wish to document some of their experiences and present them for the Achievement Program. Alternately, you may wish to have guest speakers attend your sessions.



The microphone icon appears when a guest speaker would be beneficial to explain the section/activity's content. Again it is suggested that if the leader does not have a high understanding of small engines, the leader should ask experts to come and assist with the content of the meetings.

Here are some suggestions of guest speakers and/or places to visit in your community:

- A local mechanic or repair shop
- The mechanical engineering department of a local college or university
- A local auto manufacturing facility
- A local engine parts dealer or manufacturer
- A workplace in which small engines are used frequently (ex. farm, landscaping company)
- A local company specializing in the development of new engines or fuels

Achievement Ideas

The Achievement Program offers members the opportunity to share with others what they learned from the project. Each 4-H club must hold an Achievement Program providing the opportunity for each 4-H member to display and/or demonstrate project work.

- Gather all of the posters, pamphlets and other resources created by members throughout the course of the project, and create an information display to put up in the community. The display could be about safety, small engine repair and maintenance, etc. Some ideas of places to set up your display: a library, the local fair, schools, or a community center OR use the gathered information and create an information kit to give other small engine groups. The kit can include information such as, where to find an engine, how to save money when buying tools and parts, contact names for guest speakers, and field trip ideas.
- Do a demonstration in the community of what was learned over the course of the project. Show off the skills learned and teach others in the community about topics covered at the meetings. Demonstrations could be held at the local fair, schools or other community events.
- Create a wiki page or simple website. Use the information gathered as content and post pictures taken during the course of the project. Design it to be used as resource for other 4-H members and leaders during another small engines project, or design it to be used by all.

Special Projects

You may also wish to have each of your members work on a special project throughout the course of the meetings. The projects can be done individually or in a group. A special project will encourage members to focus on a specific goal outside of their engine project, and can be presented during the Achievement Program. Having members complete a special project is an especially good idea if all members are working on the same small engine or are sharing an engine in groups. This way the members have both a completed team project and each has completed on his/her own. Here are some ideas of special projects for members.

1. Build a Reference Board

Take apart an engine, clean the parts and mount them on a sheet of plywood. Label the parts, and include any tips or interesting information found about them. Use this board as a reference for future work on small engines. It should be used by not only the members who created it, but for the entire group.

2. Create a Photo Album/ Scrapbook

Take photos at meetings and document the progress of the member's and their small engines throughout the project. The album/scrapbook could also include photos of engines they use/see everyday. Present the finished product at the Achievement Program, or make photocopies for each member of the group as a keepsake.

3. Small Engine Safety Booklet/Video/ Website

Choose 10-15 guidelines related to small engine safety, and produce a booklet, video or website explaining the guidelines and their importance to those that work with small engines. Present or advertise the finished product at the Achievement Program, and if desired pass it on to other small engine clubs for their reference.

This special project could also be done on the topic of small engine history, or new developments in small engines.

4. New Sources of Fuel Presentation

Choose an alternative fuel, and/or engine that has been designed to accommodate an alternative fuel. Research this new fuel source and how it affects the world of small engines. Create a presentation to present to a group of people. Questions to consider include: Why is it important to consider alternative fuels? What alternative fuels are available now, or will be in the future? How will small engines and the machines that use them have to change in order to accommodate these new fuels?

Congratulations!

on successfully completing
the 4-H Ontario Small Engines Project,



**SMALL
BUT MIGHTY
MACHINES**

Leaders Signature:

Date:

Advice from Other Leaders

1. If possible, find other adult helpers, and make a definite schedule based on their availability. Reminder: it is strongly suggested that all volunteers are screened. No unscreened adult helper can be left in a “position of trust” with members, one screened volunteer must always be present.
2. Take time to teach members to use their observation skills. This is particularly important for projects such as small engines, where members must buy expensive tools and equipment, and safety considerations are of great importance.
3. Provide or have members bring in a variety of containers such as plastic food containers, zip-lock bags and coffee cans. Bring labels so that they can put their names on their own materials.
4. If possible, have a camera present at each meeting. Documenting work on their engines will give members a sense of where they’ve done, and how far they’ve come. These photos can be used for community displays or at the Achievement Program.
5. Emphasize the importance of recording information throughout the project. Make sure members document all important information about their engines (ie. torque settings, compression tests) before disassembling it.
6. Make a list of the tools available and keep it on a clip board in the storage area. When members have cleaned and replaced the tools at the end of each session, have them do a check to ensure that tools have not been misplaced.
7. Encourage members to keep a small notebook and a pen with them at all times. Important information can be forgotten if it isn’t written down, and it doesn’t matter if the notebook gets a little dirty.
8. When ordering or picking up new parts, take old parts with you. This will prevent unnecessary trips to the shop, as well as unnecessary returns or exchanges.
9. When disassembling an engine, put parts in labeled zip-lock bags, and lay them out in the order they were disassembled.
10. Have members sketch their engines before and during work. This will improve their observational skills, and give them a guide from which to work.
11. Cover the garage floor and other surfaces with cardboard or other protective materials. At some point or another, things will get messy.
12. As a rule, always test the smallest and simplest causes first. Don’t take apart an entire engine until you’ve determined whether it can be fixed with simpler repairs.

**Adapted from the Saskatchewan 4-H Small Engines Leader’s Guide*

General Notes on Learning

1. Keep members involved and engaged in the project, both mentally and physically. Mix theoretical sections with hands-on practice with actual equipment and parts.
2. Explain the relevance of each activity, both to their present circumstances, and to their future education and career goals. Learners are more likely to participate and put effort into an activity if they know that it will help them to excel with small engines, and in other areas of their lives.
3. Be supportive. A new area of study, such as small engines, can be daunting to some, and it's important for them to know that they can ask leaders and fellow members for help at any point in the project. Create an atmosphere in which there is no such thing as a silly question, and in which all members are encouraged to help find answers.
4. Never underestimate the importance of structure. Time limits and deadlines are essential to the learning process in general, and will help members to be better students, and better workers.
5. Positive reinforcement is an incredibly effective motivational tool. Correcting errors is important, but so is letting members know that they're doing well. Praise them liberally for being punctual, organized, cooperative, efficient and enthusiastic. Even the smallest word of encouragement can be important.
6. Repetition is also an important learning tool, especially with younger members. Small engines are a complex area of study, and giving members the opportunity to review what they've already learned is very helpful. You may wish to use a review question as the Roll Call for each meeting.
7. Regular feedback is essential. It allows members to correct errors before they proceed to the next task, and to repeat their positive accomplishments.
8. Variety is the spice of life, and is critically important to learning. Members in any 4-H group are likely to come from a variety of age groups, educational backgrounds and levels of experience. Provide a variety of different engines, bring in guest speakers, organize field trips, experiment with different teaching methods, and encourage members to learn from many types of resources.
9. The order in which topics are covered is also important. Make sure members have learned essential skills before proceeding to the next stage.
10. It's likely that many of the members will have previous experience, knowledge or interest in small engines. Don't be afraid to relate activities to what they do in their every day lives.
11. As often as possible, allow members to experiment and work with actual machines. This not only reinforces the basic information they've learned, but also gives them confidence in their own abilities, allows them to problem solve, and fosters independence.

**Adapted from the Saskatchewan 4-H Small Engines Leader's Guide*

Useful Web Resources

- www.wsib.ca (Workplace Safety and Insurance Board)
- www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index-eng.php (Environmental and Workplace Health - Workplace Hazardous Materials Information System=)
- www.small-engines.com
- <http://www.engr.colostate.edu/~allan/engines.html>
- <http://www.grc.nasa.gov/WWW/K-12/aerores.htm>
- <http://www.grc.nasa.gov/WWW/K-12/Enginesim/index.htm>
- www.science.howstuffworks.com

Useful Print Resources

- Atkinson, Michael L. *Mechanics of Small Engines*. McGraw-Hill, 1989
- Choate, Curt and John Haynes. *Small Engine Repair*. Haynes Manuals, 1999
- Dempsey, Paul. *Small Gas Engine Repair*. Blue Ridge Summit: TAB Books, 1993
- Hunn, Peter. *The Small Engine Handbook*. MBI Publishing Company, 2005
- London, Daniel. *Small Engine Care and Repair: A Step-By-Step Guide to Maintaining Your Small Engine*. Chanhassen: Creative Publishing, 2003
- Radcliff, R. Bruce. *Small Engines*. American Technical Publishers, 1997
- Rivele, Richard J. *Chilton's Guide to Small Engine Repair*. West Chester: W.G. Nichols, 1994
- Rudman, Jack. *Small Engine Repair*. National Learning Corporation, 2001
- Schuster, William. *Small Engine Technology*, Wheeler Publishing, 1998
- Stagner, Eugene W. *Small Engines: Fundamentals and Service*. Pearson Education Canada, 1997
- Turner, J. Howard. *Care and Operation of Small Gasoline Engines*. Athens: American Association For Vocational Instructional Materials, 1986

Basic Equipment List

At least one engine must be present at meetings for leaders and members to truly “learn to do by doing”. Depending on the availability of resources, you may wish to bring in various models of engines and more complex equipment. You may want all club members to work on one engine, or have smaller groups of members each work on their own engine. There are a few things every small engines club should have on hand. To keep track of tools and equipment, label or engrave them and keep a checklist in the storage area. If it is possible, one set of basic equipment should accompany each small engine present at meetings. To save money encourage members to borrow, rather than purchase all of the tools and supplies required. Members can also work in teams, and share tools and supplies.

Tools

- Slot head screwdrivers (4", 6", 8")
- Phillips head screwdrivers (4", 6")
- Spark plug deep sockets (13/16" x 3/8")
- Drive, (3/4" x 3/8")
- Ratchet handle (3/8" drive)
- T-handle (3/8" drive)
- Open end wrenches (7/16", 1/2", 9/16")
- Combination pliers (7")
- Needle nose pliers
- Nut drivers (1/4", 3/8")
- Socket set (3/8", 7/16", 1/2", 5/8", 9/16")

Supplies

- Degreaser
- Wire brush
- Sandpaper
- 2 paintbrushes
- Bristle brush
- Petroleum jelly
- Baking soda
- Pail
- Putty knife
- Wooden scraper
- Pen knife
- Clean rags
- Oil
- Gasoline
- Solvent

**Adapted from the Saskatchewan 4-H Small Engines Leader's Guide*



THE TECHNICAL TERMS

A Glossary of Everything Small Engines

Abrasive- a type of material that is used to wear down other substances or surfaces

Accelerator Pump - A small cylinder and piston controlled by the throttle, providing an enriched air-fuel mixture during acceleration.

Additive- chemicals which help oil work better when added to an engine

Alloy- a type of metal that is created by mixing two or more base metals together

Alternating Current (AC)- current that flows in one direction, and then in the opposite direction. This type of current is used in homes.

Antifreeze- a type of liquid that has a lower freezing point and higher boiling point than water. It may be put into an engine to keep it from freezing in cold weather.

Bearing- the surface of a machine part on which another part turns or moves

Bore- the diameter of the cylinder

Bushing- a friction type of shaft bearing

Butterfly Valve- a valve in a carburetor that consists of a disc that turns and acts as a throttle

Camshaft- the shaft in an engine that pushes the intake and exhaust valves open

Capacitor- also known as the condenser

Carbon- a type of material that is hard and black, which forms when too much fuel is mixed with the air in the cylinder

Carburetor- an engine part that mixes the right amount of gas with the right amount of air so that ignition may happen

Centrifugal- movement away from the centre

Choke Valve - modifies the air pressure in the intake manifold, modifying the ratio of fuel and air quantity entering the engine. It supply's a richer fuel mixture during engine start than at other times. Most choke valves in engines are actually butterfly valves that are mounted in the manifold above the carburetor jet. It produces a higher partial vacuum, drawing more fuel into the intake stream.

Combustion- the process in which fuel is ignited and burned

Condenser- an electrical device used to collect and hold electricity

Connecting Rod- the part which connects the piston to the crankshaft

Corrosion- the chemical process in which metal or other materials are eaten away slowly

Counterbalance- a weight that is used to balance a force

Crankcase- the part of the cylinder block in which the crankshaft revolves

Crankshaft- the part of the main shaft of an engine that is rotated by the piston and connecting rods



Current- the flow of electrons through a conductor which is measured in amperes (a unit of electric current)

Cylinder Block- the main part of any engine that houses the cylinders

Cylinder Head- the metal cover bolted to the top of the cylinder block

Diaphragm- a flat, rubber disc or cloth that separates the fuel tank from the pump in an engine

Diesel- a type of engine that works by injecting fuel and ignites it in very hot, compressed air

Direct Current (DC)- electrical current which flows in one direction, but not in the other. This may be found in batteries and dry cells.

Diode- a device that converts alternating current (AC) to direct current (DC), also known as a rectifier

Electrodes- a pair of wire-like parts in a spark plug that extend into the cylinder and make a gap that allows the electrical spark to jump across

Electrolyte- a type of liquid that conducts electricity, such as water and sulfuric acid in a battery

Extension- any part that extends or adds length

Filter- a special screen full of tiny holes that collects dust and dirt, but allows air to pass through

Float Chamber - a device in the carburetor that automatically meters the fuel supply to the engine. It allows liquid within the chamber to lift a float, which is linked to a valve that regulates the liquid intake.

Flooding - when an engine is fed an excessively rich air-fuel mixture that cannot be ignited. Occurs when the ignition system is weak and does not start the engine quickly, or when the carburetor is pumped too much before starting the engine; causing the engine to fail to start until the excessively rich mixture has been cleared.

Flywheel- a wheel that attaches to the crankshaft and helps to start the engine and keep it running smoothly

Friction- resistance between two things, caused by rubbing together, that causes heat

Gasket- a flat piece of material made from rubber, cork, paper or asbestos that is fitted between metal parts to prevent fluid or air from escaping

Governor- the part of an engine that controls speed

Ground- an electrical connection or contact to the cylinder block

Hone- an abrasive tool used to make holes bigger, to ensure that they are the right size and to polish them smoothly

“Hot start” - high temperatures cause fuel in the carburetor float chamber to evaporate into the inlet manifold, causing the air/fuel mixture to exceed the upper explosive limit and the engine to flood. Usually happens in hot weather.

Inhibitor- a chemical that stops or slows rust

Insulator- material that does not conduct electricity that is used to prevent shock, injury and damage OR a metal that does not conduct electricity



Intake Manifold- a pipe that brings the fuel/air mixture from the carburetor to the cylinder for combustion

Jet- a tube with a small opening that allows air or liquid to pass through it

Lapping- using an abrasive mounted on a special backing (brass, wool, leather, etc.) to polish something

Lobe- a rounded, projecting part of a revolving shaft

Lubrication- oil or grease added to an engine to allow parts to slide quickly and easily, without getting too hot

Magnet- metal which has a force field around it that attracts some other types of metals

Magneto- a device that creates an electrical spark and ignites the fuel in the cylinder

Mesh- a net or screen made of fine wire or another substance

Peen- bending or flattening materials, including metal

Pilot- a device attached to valve seat cutters and grinders that guides and holds them in the correct position while working

Piston- a cast cylindrical piece of metal that fits in the cylinder of the engine and moves up and down

Porcelain- a hard, brittle material, similar to china

Port- a hole in the cylinder wall that lets fuel and air in, while letting exhaust gases out

Pre-ignition- the burning of the air/fuel mixture that occurs before normal ignition

Radiator- a device that gives off extra heat into the air

Ratchet- a mechanical device that limits free movement to one direction at a time

Reamer- a tool used to make holes larger

Reed- a thin, flat strip of springy material

Rotary- the motion of turning on a shaft

r/min or rpm- the number of revolutions that happen in one minute

Short Circuit- making a new, shorter path for electricity (sometimes accidentally), which makes the original circuit stop working

Shroud- a covering that directs cooling air, and can also serve as a safety cover

Solvent- a liquid that is used to clean surfaces, which is often flammable

Spark Plug- a device that allows a spark to jump across a small gap and ignite fuel

Sprocket- a wheel edged with teeth that catch holes in chain links and make another sprocket turn

Stationary- staying in one place or position

Suction- a force that moves liquid or air from high pressure to low pressure

Sump- a container for holding oil or other liquids

Swivel- to swing or turn on a hinge pin

Terminal- a point in electrical devices where wires are connected



Thermostat- a device that helps to control the temperature of an engine

Throttle- a valve that controls the amount of fuel and air allowed into the cylinder of an engine

Timing Gears- devices used to turn the camshaft and open and close the valves at the correct time

Torque- the amount of turning force applied to, or by a shaft

Transistor- a small electronic device used to control an electric current

Troubleshooting- the process of finding what's missing or not working properly

Tungsten- a hard, white metal that conducts electricity well

Universal- a double-hinged connector used to apply torque through a hinge, also called a U joint

Vacuum- an area of very low air pressure into which air always tries to move

Valve- a device used to control the movement of gas, air or liquid through an opening

Valve Lifters- small rods with one flat end that push a valve open

Vane- a flat metal or plastic surface fastened to a shaft and moved by air or wind

Venturi- a narrow point in a carburetor that causes a low pressure area around the fuel jet

Viscosity- the thickness of a liquid

Volt- a unit of measure used for electrical pressure

Warp- to bend or twist something out of shape

**Adapted from Saskatchewan 4-H Small Engines Member's Guide*





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MEETING 1

Taking Care: Small Engine Safety

Meeting Objective: *to demonstrate and develop safe work habits in members*

Suggested Roll Calls

- Name a machine that uses a small engine.
- Name one thing you want to learn about small engines.
- What is your favourite machine that uses a small engine?

Suggested Meeting Agenda (3 hrs.)

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Club Business/Parliamentary Procedure	Complete Health and Safety Forms, elect an Executive, distribute Record Books and have members fill out the Club Information and Meeting Dates pages, etc	30 min
Topic Information Discussion	Discuss general safety when working with small engines, and show members different WHIMIS and WSIB materials.	25 min
Activity Related to Reference Material	Activity # 1 - The Safety Agreement	20 min
	Activity #5 - Safety Signs	15 min
	Activity #7 - Tips for Tools (Junior) - Experienced members can participate by running the activity, and explaining uses/ procedures to the less experienced members.	30 min
Judging Activity	Activity #10 - Judging Safety	20 min
Clean up/ Adjourn	Remind members to bring their tools, supplies and equipment needed for the next meeting. Ask members to fill out their project goals in their Record Books.	10 min
Social Time / Snacks		15 min

TOPIC INFORMATION

General Safety and Small Engines

Because working with small engines entails handling flammable and corrosive substances, and working with moving parts, safety is of the utmost importance. Fire, contact with toxic substances, and personal injury are all possibilities, but accidents can be avoided with the proper precautions. As a leader, it is essential to teach members the proper method of manipulating and storing an engine, as well as proper handling of tools, equipment and fuel.

Safety Equipment

Insist that members wear protective eye wear, gloves, earplugs/protectors, protective clothing and appropriate footwear whenever working with engines. Members should avoid wearing loose clothing or jewellery, and should tie back long hair.

Safe Workspace

At the beginning and end of each meeting, ensure that the workspace is well-ventilated and clear of debris. Tools, equipment and supplies must be stored in appropriate containers, and there must be sufficient space for members to work. Spilled oil, gasoline, or other substances must be cleaned up immediately. No one should be allowed to smoke in the workspace, or operate machinery while under the influence of alcohol or drugs. Emergency supplies, such as fire extinguishers and first aid kits, should be kept nearby, and all members, leaders and helpers should be instructed about their use. Members should not play or rough house near machines.

Safe Handling of Engines and Supplies

Educate members and other helpers about the importance of storing fuel in approved containers, and keeping it in a safe place, away from sparks or open flames. Engines should never be started unless filled with the appropriate amount of oil, and the recommended type of gasoline. Refilling oil or gasoline or handling the engine should only be done while the engine is turned off and after it has been allowed to cool. Engines should also be allowed to cool before storing them. Spark plugs should be disconnected before any maintenance is performed, and when the engine is not in use. All equipment and tools should be kept clean, and in good working order. Members and helpers should not be allowed to work on small engines until they have been informed of these rules.

**Adapted from the Saskatchewan 4-H Small Engines Leader's Guide*

Advice from Other Leaders

1. Work the way you expect your members to work. Remember that they are watching you for cues, and if you take safety precautions, they are more likely to do so as well.
2. Injuries can be embarrassing, but leaving them untreated can cause further harm. Let members know that accidents happen, and that it's important that you're told about any mishaps, no matter how small. The important part is to learn from mistakes.
3. Play "what if" with members at the beginning of each session. Take a few minutes and ask them to identify possible safety hazards, and to explain how they can deal with them. Once they're aware of danger, they'll be more likely to avoid it.
4. Treat safety as a regular part of your activities. If it's made into part of the routine, members will become accustomed to it.
5. If possible, take a first aid course, and/or keep literature on hand for members and helpers. If any of the members have this sort of training, ask them to let you know. In all cases, make sure there are first aid supplies on hand.
6. Emphasize that the safe work habits they're learning are useful outside of the club too. These are things they should apply at home, at school, and at play.
7. Treat the mind as the most important piece of safety equipment. Goggles, gloves and protective footwear are essential, but it's better to put one's self in a situation where accidents don't happen in the first place.
8. Involve parents, teachers, community members and helpers in the development of safe work habits. Ask them to reinforce these habits at home and at school, and to talk with members about what they've learned.
9. Make it personal. Allow members to share personal experiences about safe or unsafe conditions they've encountered. Hearing things from their peers will make an even bigger impact.

**Adapted from the Saskatchewan 4-H Small Engines Leader's Guide*

SAFETY RESOURCES AND POSTERS

82

In Case of Injury at Work

1 Get first aid immediately, if needed

2 *Worker:* Tell your employer about the injury
Employer: Arrange and pay for transportation to get medical care, if needed

3 *Employer:* Pay worker's wages for day of injury

4 *Employer:* Report injury to WSIB within 3 days if it involves

- health care treatment, or
- time away from work, or
- lost wages

WSIB Workplace Safety & Insurance Board
CSPAAT Commission de la sécurité professionnelle et de l'assurance contre les accidents du travail

Questions? Call 1-800-465-5606
www.wsib.on.ca

What's in it for you?

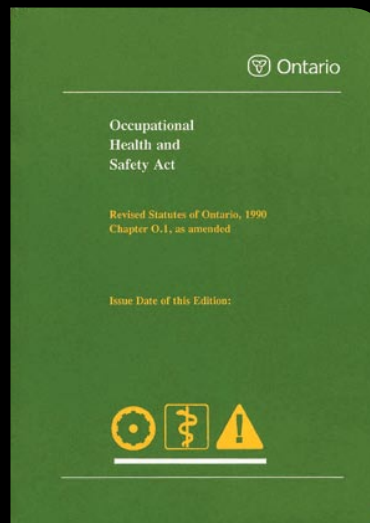
Ontario's Occupational Health and Safety Act

EMPLOYERS and SUPERVISORS

KNOW YOUR DUTIES AND RESPONSIBILITIES!

SECTIONS 25, 26, 27

- Take all reasonable precautions to protect the health and safety of workers.
- Provide information, instruction and supervision.
- Post your written health and safety policy and establish a health and safety program if there are six or more workers.
- Post a copy of the *Occupational Health and Safety Act* and ensure compliance.
- Provide and maintain required equipment, materials and protective devices. Employers must also make sure they are used properly.



WORKERS

KNOW YOUR RIGHTS AND RESPONSIBILITIES!

SECTIONS 8, 9, 28, 43

- Right to participate in keeping your workplace healthy and safe.
- Right to know about hazards.
- Right to refuse work if you believe it is dangerous.
- Comply with the law and company rules.
- Wear your safety glasses, safety shoes and any other protective equipment.
- Tell your supervisor if you notice hazards or health and safety laws being contravened.

EVERYONE

NEEDS TO UNDERSTAND THE LAW AND WORK TOGETHER TO PREVENT WORKPLACE INJURIES AND ILLNESSES!

- The *Occupational Health and Safety Act* sets out the general principles for everyone.
- Get to know the specific regulations for your workplace and hazards that exist.



Workplace Safety & Insurance Board

Commission de la sécurité professionnelle et de l'assurance contre les accidents du travail

www.wsib.on.ca

www.owa.gov.on.ca



WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM

Classes of WHMIS Controlled Products

CLASS A – Compressed Gas



CLASS B – Flammable and Combustible Material

Division 1: Flammable Gases

Division 4: Flammable Solids

Division 2: Flammable Liquids

Division 5: Flammable Aerosols

Division 3: Combustible Liquids

Division 6: Reactive Flammable Materials



CLASS C – Oxidizing Material



CLASS D – Poisonous and Infectious Material

Division 1: Materials Causing Immediate and Serious Toxic Effects

Subdivision A: Very Toxic Material

Subdivision B: Toxic Material



Division 2: Materials Causing Other Toxic Effects

Subdivision A: Very Toxic Material

Subdivision B: Toxic Material



Division 3: Biohazardous Infectious Material



CLASS E – Corrosive Material



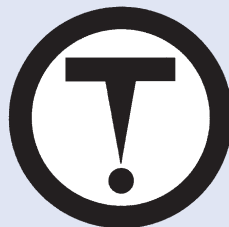
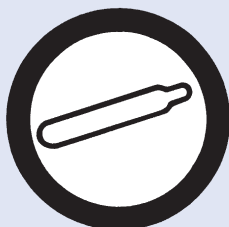
CLASS F – Dangerously Reactive Material



Do You Know These Vital Signs?

THE HAZARD SYMBOLS OF WHMIS

CLASS A
Compressed Gas



CLASS D-2
Poisonous and Infectious Material
(material causing other toxic effects)

CLASS B
Flammable and Combustible Material



CLASS D-3
Poisonous and Infectious Material
(Biohazardous Infectious Material)

CLASS C
Oxidizing Material



CLASS E
Corrosive Material

CLASS D-1
Poisonous and Infectious Material
(material causing immediate and serious effects)



CLASS F
Dangerously Reactive Material

WHMIS provides you with information on the safe use, storage, handling and disposal of hazardous materials at Canadian workplaces.



Workplace
Hazardous Materials
Information System

For more information, consult the MSDS, and visit the Health Canada WHMIS Web site:
<http://www.hc-sc.gc.ca/whmis>

**ROAD TO ZERO:
A Prevention Strategy**
for Workplace Health and
Safety in Ontario
2008 – 2012

Four Thrusts

First Thrust:

Create a national habit of safety.

Second Thrust:

Provide prevention system leadership

Third Thrust:

Instill an evidence-based, priority-focused and
outcome measurement mindset

Fourth Thrust:

Develop WSIB and prevention partner capabilities

My Prevention Pledge

Prevention is not one person's responsibility.
It's everyone's responsibility.

If we all do a little, we can achieve a lot.

I pledge to: (Type pledge below.)

Name (Please Print)

Please print form & sign.

Signature



January 2008

**ROAD TO ZERO:
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Signature



January 2008



WHMIS

Quick Facts

Workplace Hazardous Materials Information System



What is WHMIS?

As a **worker**, you have the **right to know** about the hazards of chemicals used in your workplace. To support your right to know, laws across Canada require chemical suppliers and your employer to provide you with information about hazardous products and how to protect yourself. WHMIS applies to products specifically for use in workplaces.

Labels

Controlled products from Canadian suppliers display a WHMIS label like the one shown below. In addition to the hazard symbols, a WHMIS supplier label identifies the product and lists hazards, precautions, and first aid measures. Additional information is provided on the MSDS.

Workplace labels are required on portable containers in the workplace.



Hazard Classes / Symbols

Hazard symbols appear on product containers as a visual alert. Products are classified by the supplier to identify hazardous properties such as toxicity, flammability and reactivity. A product that has hazardous properties, is called a controlled product, and one or more WHMIS symbols must appear on the product label. These eight symbols alert you immediately to a product's potential hazards.



A - Compressed Gas



B - Flammable/Combustible



C - Oxidizing



D1 - Immediate and Serious Toxic Effects



D2 - Other Toxic Effects



D3 - Biohazardous



E - Corrosive



F - Dangerously Reactive

Material Safety Data Sheets (MSDSs)

Material Safety Data Sheets are provided by the supplier to give users detailed information about the hazards and safe use of products. Before using any product for the first time review the MSDS for information on health effects, fire hazards, handling, storage, and personal protection.



Education and Training

If you work with, or may be exposed to, hazardous materials at your workplace, you must be trained. WHMIS training has two aspects:

- 1) Education – understanding the principles of WHMIS, and the meaning of the information on labels and MSDSs, and
- 2) Training – workplace-specific training on how to apply this information to materials in actual use at your workplace, including: procedures for storage, handling, disposal, and personal protection.

The employer is responsible to ensure that workers have been appropriately trained.

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For additional information and resources visit www.whmis.gc.ca and/or www.ccohs.ca



WHMIS Quick Facts

Workplace Hazardous Materials Information System



Routes of Workplace Exposure

There are **four main routes of exposure** by which chemicals can contact and/or enter our bodies. Many chemicals can cause direct effects at the point of contact, such as irritation of the skin, eyes, mouth or nose.

Some chemicals can also be absorbed into the body and cause harmful effects on other body systems like the blood, liver or nervous system.

Routes of Exposure

Some chemicals are not harmful by any route of exposure, while others are harmful by some or all of the routes of exposure.

Inhalation (Breathing) – Chemicals in the air can be inhaled into the body through the mouth or nose. In the workplace airborne chemicals may occur in different forms such as gases, vapours, dusts or mists.

Skin Contact – Many chemicals can cause direct effects at the point of contact with the skin. Some chemicals can be absorbed into the body through the skin.

Eye Contact – Chemicals can also come in contact with the eyes as dusts, mists, gases, vapours, or when liquids are splashed. Some chemicals can be absorbed through the eyes causing harmful effects elsewhere in the body.

Ingestion (Swallowing) – Chemicals can be ingested through the mouth. In workplaces, ingestion can result from hand-to-mouth contact, consuming contaminated food or drink, or smoking cigarettes that have come into contact with a chemical or unclean hands. Sometimes workplace chemicals are accidentally swallowed.

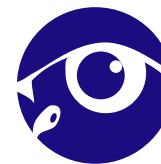
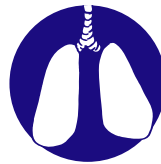
Note: In some workplaces, like hospitals or veterinary clinics, **injection** is also a possible route of exposure. Biological or chemical substances can be injected into the body by accidentally puncturing the skin with a contaminated needle or other sharp device. **Following Universal Precautions is the best means of protection.**

Inhalation (Breathing)

Skin Contact

Eye Contact

Ingestion (Swallowing)



Protective Measures

To prevent harmful health effects, take steps to eliminate or reduce the hazard. Control at the source, such as substitution with a less hazardous material or industrial process, is the best method.

Bear in mind the specific hazards of the material and the extent and pattern of exposure.

Workplace Control Measures

Route of Exposure	Controls / Practices (apply to all routes of exposure)	Personal Protective Equipment (PPE)*
Inhalation	Engineering Controls (isolating or removing the hazard): <ul style="list-style-type: none"> • Enclose process 	Respirators and protective clothing suitable for the chemical
Skin Contact	<ul style="list-style-type: none"> • Provide local exhaust ventilation Administrative Practices	Chemical protective clothing suitable for the chemical – gloves to full suits
Eye Contact	<ul style="list-style-type: none"> • Time work so fewer workers are exposed, 	Chemical safety goggles, face shield
Ingestion	<ul style="list-style-type: none"> • Work upwind of mixing operations, • Shower after shift • Change clothes • No food in work areas 	Chemical protective clothing suitable for the chemical – gloves to full suits

* Personal Protective Equipment (PPE) can be unreliable. If it fails, it can leave a person unprotected.

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For additional information and resources visit www.whmis.gc.ca and/or www.ccohs.ca



WHMIS Quick Facts

Workplace Hazardous Materials Information System



Supplier Labels

The product label is your first source of information about the hazards of a product and how to protect yourself. Controlled (hazardous) products from suppliers must display a WHMIS label with a hatched border and the following seven categories of information.

1. Product Identifier

The product name exactly as it appears on the container and on the Material Safety Data Sheet

2. Supplier Identifier

The company which made or packaged the product, and is responsible for the label and MSDS information. Contact the supplier for additional information on the product

3. Hazard Symbols

One or more WHMIS symbols, depending on the WHMIS classification of the product

4. Risk Phrases

Brief statements of major hazards, based on the WHMIS classification of the product

5. Precautionary Measures

Brief descriptions of essential precautions, specific protective equipment, and emergency measures

6. First Aid Measures

Immediate steps to be taken by trained first aiders at the scene of an incident

7. MSDS Reference

Labels provide key information to alert you about critical hazards, precautions and first aid measures. The MSDS contains much more information on the safe use of the product. Always read the MSDS before working with a hazardous product.

What to look for...

When reading a supplier label, look for consistency between the information elements. Do the hazard symbols match the risk phrases, and the information on the MSDS? Are the precautions and first aid measures consistent with the hazards? If you have questions, contact the supplier.

Sample Supplier Label

1 SOL 27 CLEANER
X-Y-Z CHEMICAL CO.

2

3

4

5

6

7

Precautions: Eliminate all ignition sources. Keep away from sparks and open flames. Bond and ground transfer containers and equipment to avoid static accumulation. Ventilate area. Empty containers are hazardous, may contain flammable, liquid residue or vapours. Wear suitable eye protection (chemical safety goggles).

Extremely Flammable
Liquid
Liquide extrêmement inflammable

Toxic - Eye Irritant
Toxique - Irritant oculaire

First Aid: Flush contaminated eyes or skin with water. If overcome by vapours, move victim to fresh air. If ingested, do NOT induce vomiting. Obtain medical attention.

Precautions: Éliminer toute source d'inflammation. Tenir éloigné des étincelles et des flammes. Brancher à la terre les contenants de transfert et l'équipement pour éviter l'accumulation d'électricité statique. Bien aérer le secteur. Les contenants vides présentent un danger, car ils peuvent contenir un résidu de liquide ou de vapeur inflammable. Porter un dispositif de protection oculaire (lunettes protectrices contre les agents chimiques).

Premiers soins: Rincer la peau ou les yeux contaminés avec de l'eau. Changer d'environnement pour donner de l'air frais à la personne incommodée. Si avalé, NE PAS faire vomir. Contacter un médecin.

See Material Safety Data Sheet (MSDS) for more information.
Pour de plus amples renseignements, consulter la Fiche signalétique (FS).

Supplier labels must be bilingual (English/French), easy to read, and durable. If the label is lost, damaged, or no longer readable, the product must be relabeled.

Special Provisions

1. Controlled products may be imported without a supplier label. The importer or purchaser must provide the required label information.
2. Certain categories of controlled products (containers under 100 mL, laboratory products, and laboratory samples) may legally show less (or a variation from the) information than indicated above.

Always read the MSDS before working with a hazardous product.

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For additional information and resources visit www.whmis.gc.ca and/or www.ccohs.ca



Health Canada
Santé Canada



Canada

ACTIVITIES

Activity #1: The Safety Agreement (20 min)

Care and responsibility while working with small engines - *To identify safety concerns.*

Materials/Resources: • Chart Paper and markers • Paper and pencils

Put members into small groups composed of all age levels, and provide each group with paper, pencils, and a variety of print resources. Ask each group to list their own responsibilities in working with small engines safely. After approximately 10 minutes, make a collective list on chart paper and discuss findings. Finally, have students read and sign a safety agreement. A sample has been provided, but you may make modifications, or if there's time you may incorporate members' suggestions into a new agreement.

This activity is intended to provide members with an insider's understanding of safety in the workplace. By having members list responsibilities for themselves, leaders allow them to understand and prioritize precautions for themselves, and discuss them with other members. This, in turn, fosters a sense of responsibility, both for their own safety and for those they work with. It is essential to establish safety concerns as having the most importance in the workplace.

1. While working on small engines, what are some of the things you can do to keep yourself and others safe?
2. Why is it so important to pay attention to safety?

THE SAFETY AGREEMENT

Safety comes first when working with small engines. While I'm working on my project, I promise to:

- Learn to read warning labels and safety instructions.
- Keep my workspace clean and free from clutter.
- Keep my materials and tools stored in the right containers and places.
- Use equipment properly.
- Wear appropriate clothing and use protective equipment.
- Listen to the instructions of my leader.
- Ask questions and ask for help when I'm not sure.
- Let my leader know whenever I see something I think isn't safe.
- Do everything I can to keep myself and others safe.

Member Name:

Signature:

Leader Name:

Signature:

THE SAFETY AGREEMENT

Safety comes first when working with small engines. While I'm working on my project, I promise to:

- Learn to read warning labels and safety instructions.
- Keep my workspace clean and free from clutter.
- Keep my materials and tools stored in the right containers and places.
- Use equipment properly.
- Wear appropriate clothing and use protective equipment.
- Listen to the instructions of my leader.
- Ask questions and ask for help when I'm not sure.
- Let my leader know whenever I see something I think isn't safe.
- Do everything I can to keep myself and others safe.

Member Name:

Signature:

Leader Name:

Signature:



Activity #2: Protect Yourself! (40 min)

Prevention of Personal Injury - *To identify potential hazards, as well as strategies to avoid them.*

Materials/Resources: • Guest speaker from WSIB or a local garage • WHIMS/WSIB Materials
• “Protect Yourself” Safety Chart • Poster board and art supplies

To be done in small groups during a session. Have students fill in the chart and then discuss as a group. To make this more challenging, leave the “Area at Risk” section blank. For juniors, put members into small groups and distribute art supplies. Assign a risk area (back, eyes, ears, etc.) to each group, and have them create a poster outlining prevention strategies for that particular area. Have senior members research products and safety equipment available for preventing injury to a particular area. Have each group do a mini-presentation, in which each member is involved, describing their poster, or the product/equipment they’ve found.

In this activity, members are asked to identify risks to various areas of the body, as well as strategies for prevention. By asking them to present their findings visually and do research into various protective equipment, members gain a broader understanding of safety issues. The mini-presentation encourages them to develop their oral presentation skills.

1. What can you do to prevent these injuries from happening?



Activity #3: The Ripple Effect! (10 min)

Prevention of Injuries to Others - *To examine the effects of injuries on others*

Materials/Resources: • Ontario Ministry of Labour & WSIB Materials • Chart paper and markers

This activity should be done as a group, in the form of a discussion. Have members brainstorm and contribute ideas of who else might be affected by workers who don’t put safety first. Write them on chart paper.

It is vital for members to recognize that while their own safety is of paramount importance, carelessness and negligence may have negative consequences for a variety of other people. In your list you should include discussions about other people present, potential members, family, co-workers, leaders and their families, as well as other members and their families. With more senior members, you may also wish to discuss the impact of injuries on the economy, and the health care system.

1. If you are injured while working on a small engine, who else around you might be affected?
2. Why is it so important to consider others when working on projects?

PROTECT YOURSELF

Area at Risk	What's the Risk?	How do I prevent this?
Back		
Ears		
Eyes		
Lungs		
Skin		
Limbs		

**Adapted from the Saskatchewan 4-H Small Engines Member's Guide.*



PROTECT YOURSELF (Answer Key)

Area at Risk	What's the Risk?	How do I prevent this?
Back	<ul style="list-style-type: none"> - heavy lifting - falls - lifting and turning incorrectly - catching a heavy falling object 	<ul style="list-style-type: none"> - proper foot placement - limit weight or ask for help - keep floor clean clear - lift smoothly, using legs and a straight back - use weight belts or other safety equipment - use machines to lift
Ears	<ul style="list-style-type: none"> - loud noises 	<ul style="list-style-type: none"> - limit time around loud noises - wear hearing protection
Eyes	<ul style="list-style-type: none"> - splashing chemicals - dust and flying objects - fumes, smoke - being hit in the eye - tools hitting the eye - compressed air used improperly 	<ul style="list-style-type: none"> - reduce risk of splashing - wear eye protection - use compressed air with caution - use fire prevention and good ventilation - anticipate movements of parts - keep distance from work - clean engines before working on them - keep tools and equipment in good repair
Lungs	<ul style="list-style-type: none"> - Inhaling dust, fumes, exhaust or fuel - flash/heat from fires and explosions - carbon monoxide poisoning - poor ventilation 	<ul style="list-style-type: none"> - wear dust mask and avoid inhaling fumes - use fire prevention and good ventilation - keep workspace clean - use solvents and other chemicals sparingly - avoid inhaling fumes
Skin	<ul style="list-style-type: none"> - exposure to fuels, solvents or battery acid - cuts or punctures from sharp, rough edges or dangerous tools - burns from flames, hot objects or electricity 	<ul style="list-style-type: none"> - inspect clothing and covers for tears and rips - keep tools in good repair - keep a safe distance from working machines - keep compressed air away from burns - keep tools and equipment out of the way - wear appropriate clothing and protective gear
Limbs	<ul style="list-style-type: none"> - punctures from tools/pressurized air - crushing from heavy tools or equip. - cuts from sharp edges/ dangerous tools - lifting, turning improperly, or catching heavy falling objects - fall 	<ul style="list-style-type: none"> - wear appropriate protective gear - keep tools in good repair - keep extra tools and equipment out of the way - keep heavy parts on a secure surface - practice safe lifting and turning techniques

*Adapted from the Saskatchewan 4-H Small Engines Member's Guide.

**SMALL
BUT MIGHTY
MACHINES**

Activity #4: Steps to Safety! (30 min)

General Safety Practices - *To learn and discuss general attitudes and precautions.*

Materials/Resources: • “Steps to Safety” Worksheet • Props (optional)

For this activity, members are divided into several small groups. They may be composed of various age groups and levels, depending on the wishes of the members/leaders. Each group is assigned one or two of the seven steps from the handout provided, and is given 10-15 minutes to prepare a two minute sketch in which they act it out. This can take the form of simple, straightforward role playing, or can be done in a more creative manner. Each sketch should give at least a few specific suggestions and examples. If members wish, and if there are appropriate materials available, they can use/create props. If time permits, you may also have a short discussion on each skit as a group.

Role-playing is a fun, entertaining and creative way to help members retain important information. In a group setting, it promotes cooperative efforts, and encourages creativity and problem solving. It is also an excellent way to develop presentation skills and to teach members to think on their feet.

1. What can you and your fellow members do to make sure each safety step is followed?
2. How can you discuss safety concerns with others?

Activity #5: Safety Signs (15 min)

Common Safety Symbols - *To identify safety signs and symbols used in industry.*

Materials/Resources: • A guest speaker from WSIB or a local garage • WSIB & WHIMS Materials • “Safety Symbols” Worksheet

This activity may be done in several ways, depending on the familiarity of the members with the symbols. For more experienced members, the worksheet provided may be used for quick review and reference. For younger members, you may wish to discuss the symbols further, or make a contest out of seeing who can match the correct words with the symbols first. To make the activity even more interactive, the symbols may be enlarged to the size of a regular piece of paper and used as “flash cards”. All members should keep a copy of the worksheet with their Record Book. The worksheet can be given as a take home activity, or filled in as a group during a session.

The safety symbols given on the worksheet pertain directly to the Small Engines Project. However, there are a number of other symbols which may be covered if members are interested, and if the leader wishes to cover them for future projects. As a take home activity, members could research additional symbols and bring in any they feel may be useful.

1. Why is it necessary to know what each symbol means?



STEPS TO SAFETY!

This list is useful when working with small engines, but also with any activity. All people working on a project including members, leaders, and other helpers must follow these steps.

1. Name the Risks

Knowing the dangerous parts of your activity will allow you to be more careful and ask for help when you need it.

2. Safeguard the Work Area

Avoiding unnecessary clutter will give you room to move and work without injuring yourself.

3. Wear Necessary Protective Equipment

Equipment and materials can be replaced, but your body can't. Protect it!

4. Use the Right Tools

Different pieces of equipment are made for different jobs. Know the difference and always use the right tool.

5. Follow the Correct Procedure

Skipping steps and cutting corners make for dangerous situations.

6. Monitor Work Habits

Be honest and ask yourself if you and your co-workers are doing things the way they should be done.

7. Correct As Necessary

Learning from mistakes is just as important as learning from your success.

**Adapted from the Saskatchewan 4-H Small Engines Member's Guide.*

SAFETY SYMBOLS



Activity #6: Safety Word Jumble (15 min)

Key Terms in Small Engine Safety - *To review important terms and ideas in safety.*

Materials/Resources: • “Safety Word Jumble” Worksheet • Worksheets from previous activities

This activity may be done in small groups during a session, or as a Roll Call or warm-up activity. To make it more challenging for older members, you may choose to leave off the word list.

Simple activities such as this one are an effective way to remind members of what they’ve already learned, and have them review previous activities. For new members, this will reinforce the importance of taking effective notes and keeping accurate records. Review activities are also an excellent opportunities for members to ask for clarification.

1. Can you remember all of the terms in the jumble?
2. Do you know what they mean and why they’re important to this project?

Activity #7: Tips for Tools (Junior - 30 min)

Small Engines Tools and Proper Use - *To introduce younger members to basic tools and discuss their proper use.*

Materials/Resources: • “Tips for Tools” Worksheets • Examples of tool • Safety books and posters

This activity is intended for younger members who have not had much experience with use of tools, but may also serve as a refresher for older members who may be out of practice. Because part of this activity is a demonstration, you may wish to have older, more experienced members assist you.

- Distribute the worksheet provided and have members fill it out to the best of their knowledge.
- Ask them to circle or highlight any items of which they’re not sure. Allow approximately 10 minutes for this.
- Be sure to explain that this is just to assess how much experience they’ve had with tool use, and they aren’t expected to get all of the answers on the first try.
- When members have had a chance to answer as many questions as they can, bring out examples of tools and other visual materials and go through the correct answers one by one, stopping to demonstrate and discuss.
- You may also want to ask for volunteers from the group to come up and demonstrate with you.

Using a diagnostic tool such as this one will enable members to develop confidence in their previous knowledge, while identifying areas in which they need assistance. Asking for audience participation makes members more comfortable standing in front of a group, and engages learners who learn best by doing.

1. What are some of the rules for proper use of tools?
2. What might happen if tools are used improperly?
3. How can you tell is a tool is broken or not working properly?

SAFETY WORD JUMBLE

Using the word list at the bottom of the page, rearrange the letters of these words to find some of the terms you've learned in other activities.

- | | |
|---------------|-----------------|
| 1. einpooxls | 11. cieroosv |
| 2. ogglgse | 12. tcelrut |
| 3. ipoentrcot | 13. evolgs |
| 4. lpsinahgs | 14. mxnooied |
| 5. secihacml | 15. srsapk |
| 6. sriungh | 16. nteaivtinol |
| 7. ehsfldieac | 17. iepoetvnr |
| 8. nfilitg | 18. cntoaiu |
| 9. enpurutc | |
| 10. wkootbrs | |

Explosion
Face Shield
Gloves
Goggles
Lifting

Monoxide
Protection
Puncture
Sparks
Splashing

Work Boots
Ventilation
Chemicals
Corrosive
Prevention

Rushing
Clutter
Caution



SAFETY WORD JUMBLE

Using the word list at the bottom of the page, rearrange the letters of these words to find some of the terms you've learned in other activities.

- | | |
|---------------|-----------------|
| 1. explosion | 11. corrosive |
| 2. goggles | 12. clutter |
| 3. protection | 13. gloves |
| 4. spashing | 14. monoxide |
| 5. chemicals | 15. sparks |
| 6. rushing | 16. ventilation |
| 7. facesheild | 17. prevention |
| 8. lifting | 18. caution |
| 9. puncture | |
| 10. workboots | |

Explosion
Face Shield
Gloves
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TIPS FOR TOOLS WORKSHEET

Read the following sentences, and taking your best guess fill in the blanks. If you don't know the answer, circle the number. After you've finished, your leader will discuss the correct answers with you.

1. When using a wrench, always _____ it. Never _____ it.
If you have to _____ it, then always do so with an open hand, so you don't scrape your knuckles.
2. Make sure all of your tools are _____. If your tools are greasy, your hands might slip, and you might hurt yourself.
3. Always _____ your tools carefully. Putting them away in the wrong place, or leaving them out could damage them, and make them more dangerous to use.
4. Take a look at what you're wearing. Tie back your _____, and keep _____, _____ and _____ away from the tools and equipment.
5. Before you start a job, make sure you use tools that are the right _____.
6. Use the right tool for the right _____ / _____. Don't mix them up and use them for something they shouldn't be used for.
7. To keep things like dust, pieces, caustic materials and compressed air away from your face, use _____ or a _____.
8. If chisels have developed mushroomed tops, then _____
_____.
9. If a tool shows signs of wear, then _____ or _____ it as soon as possible.



TIPS FOR TOOLS WORKSHEET (Answer Key)

1. When using a wrench, always **pull** it. Never **push** it. If you have to **push** it, then always do so with an open hand, so you don't scrape your knuckles.
2. Make sure all of your tools are **clean**. If your tools are greasy, your hands might slip, and you might hurt yourself.
3. Always **store** your tools carefully. Putting them away in the wrong place, or leaving them out could damage them, and make them more dangerous to use.
4. Take a look at what you're wearing. Tie back your **hair** and keep **clothing, jewellery** and **body parts** away from the tools and equipment.
5. Before you start a job, make sure you use tools that are the right **size**.
6. Use the right tool for the right **purpose/job**. Don't mix them up and use them for something they shouldn't be used for.
7. To keep things like dust, pieces, caustic materials and compressed air away from your face, use **goggles** or **a face shield**.
8. If chisels have developed mushroomed tops, then **grind them down**.
9. If a tool shows signs of wear, then **replace or repair** it as soon as possible.

Activity #8: Engine Safety Dos and Don'ts (Junior - 30 min)

Basic Concepts in Small Engine Safety - *To review and present ideas in engine safety.*

Materials/Resources: • Worksheets and notes from previous activities
• Bristol board/ Construction Paper • Markers, magazines and art supplies, etc.

This activity may be done individually or in small groups, and may be taken home to accommodate time restrictions. Have members make a list of 5 dos and don'ts related to small engine safety. Using art supplies, as well as any other media materials available, have members create posters or pamphlets representing/ explaining these rules. They may draw their own illustrations, or cut and paste clippings from magazines or the internet. Encourage members to be creative and critical in organization, and to discuss their plans with others. Finished posters/ pamphlets may be presented to other members of the group at the other end of the session, and may be useful for community displays or at the Achievement Program.

This activity is an effective way to teach members how to produce and present material to others. Junior members will find this sort of project more accessible, and it will encourage them to think critically about how they explain and present information. Moreover, it encourages creativity and innovation.

1. What are the most important things to remember when working with small engines?
2. What is some good advice for someone who is new to small engines?

Activity #9: Do-It-Yourself Safety Quiz (Part 1 - 20 min, Part 2 - 30 min)

General and Specific Considerations for Small Engine Safety - *To review important terms and ideas in safety.*

Materials/Resources: • Paper and Pens • Notes and worksheets from previous activities

Working individually, have members go through their notes and create 1 or 2 questions to be used in a Quiz Game. The format, number and difficulty of the questions will vary with the age groups. Be sure to suggest various types of questions, such as short answer, multiple choice, true or false, matching, definitions, and fill-in-the-blank. They may also wish to write questions involving the application of safety rules to hypothetical scenarios. When individuals have written out their questions, compile them into a single quiz. At the following session use the compiled questions in a "game show" style activity. Have members compete in teams, to see who can answer the questions orally as a group, or individually.

By having members create their own quiz questions, you enable them to analyze the information covered in previous activities in greater detail, and present it in age-appropriate terms. This approach also promotes greater discussion among the group.

Activity #10: Judging Safety (20 min)

First Aid Kit Requirements - *To review and evaluate items required in a First Aid kit. Development of analytical skills and familiarization with judging techniques.*

Materials/Resources: • 4 First Aid Kits • WSIB First Aid Kit Requirements Checklist (Attached)
• Pens and “Judging Breakdown” Worksheet

Using the WSIB Regulation 101, prepare four First Aid Kits for the members to judge. Depending on the experience/age level of members judging you may wish to make the activity more easy or difficult. Discuss with the group what makes a good First Aid Kit, and then pass out the First Aid Judging Checklist. The Checklist has been created with spaces for you to add additional judging requirements, if you wish. Ask a senior member to give their reasons aloud to the group as an example for younger and less experienced members.

Whether they are involved in a competition, or just evaluating the work of their own or others within their 4-H group, members need to learn to rank and critique constructively. Judging activities not only encourages them to organize and present their work clearly and effectively, but also allow them to develop analytical and communication skills.

FIRST AID KIT JUDGING BREAKDOWN

Perfect Score

Kit Contents

/50

- All items required are present
- Correct quantity of items are present for the number of workers
- Items are new and unopened and not expired
- _____
- _____
- _____

Container

/25

- Appropriate size for contents
- No leaks
- Closes securely
- _____
- _____

Cleanliness/ neatness

/25

- Both the container and the items inside are clean and dry
- Items are organized an east to find
- _____
- _____



First +Aid

REQUIREMENTS

WSIB
ONTARIO
CSPAAT

Regulation 1101

Introduction

This brochure is about the first aid requirements of the Workplace Safety and Insurance Board (WSIB). It contains the law (Regulation 1101) and the policy on first aid.

To find out more about the Workplace Safety and Insurance Board please see our Web site at www.wsib.on.ca

Questions?

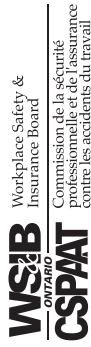
If you have questions about Regulation 1101 or the contents of this brochure, please call (416) 344-1016 or toll free 1-800-663-6639.

This brochure is available in both English and French by calling (416) 344-4200 or toll-free 1-800-465-5606, or TTY (telephone device for the deaf) 1-800-387-0050.

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www.wsib.on.ca



All employers who are subject to the *Occupational Health and Safety Act* must comply with Regulation 1101 under Section 3 of the *Workplace Safety and Insurance Act*. The Regulation states what each employer is obligated to provide in the workplace. It is printed below.

Some of the requirements of Regulation 1101 are explained in further detail starting on page 15: guidelines for the content of first aid boxes (page 15); a description of the poster known as Form 82 entitled *In Case of Injury at Work* (page 15); and how to arrange first aid training for workers (page 20).

Section 82 of the *Workplace Safety and Insurance Act* authorizes the Workplace Safety and Insurance Board (the Board) to surcharge employers who do not comply with these first aid requirements.

Regulation 1101 **First Aid Requirements**

- 1 (1) A first aid station shall contain,
 - (a) a first aid box containing the items required by this Regulation; and
 - (b) a notice board displaying,
 - (i) the Board's poster known as Form 82
 - (ii) the valid first aid certificates of qualification of the trained workers on duty, and
 - (iii) an inspection card with spaces for recording the date of the most recent inspection of the first aid box and the signature of the person making the inspection.
- (2) A first aid station shall be in the charge of a worker who works in the immediate vicinity of the first aid station and who is qualified in first aid to the standards required by this Regulation.

(3) First aid stations shall be so located as to be easily accessible for the prompt treatment of any worker at all times when work is in progress.

2 (1) A first aid box shall contain as a minimum the first aid items required by this Regulation and all items in the box shall be maintained in good condition at all times.
 (2) The box shall be large enough so that each item is in plain view and easily accessible.

3 Every employer shall at all times keep posted in other conspicuous places in the place of employment the Board's poster known as Form 82 respecting the necessity of reporting all accidents and receiving first aid treatment.

4 The expense of furnishing and maintaining first aid appliances and services shall be borne by the employer.

5 Every employer shall keep a record of all circumstances respecting an accident as described by the injured worker, the date and time of its occurrence, the names of witnesses, the nature and exact location of the injuries to the worker and the date, time and nature of each first aid treatment given.

6 Employers shall inspect first aid boxes and their contents at not less than quarter-yearly intervals and shall mark the inspection card for each box with the date of the most recent inspection and the signature of the person making the inspection.

7 The Board or its appointees may make inspections of first aid stations, appliances, services and records.

First Aid Requirements

8 (1) Every employer employing not more than five workers in any one shift at a place of employment shall provide and maintain at the place of employment a first aid station with a first aid box containing as a minimum,

(a) a current edition of a standard St. John Ambulance First Aid Manual;

(b) 1 card of safety pins; and

(c) dressings consisting of,

(i) 12 adhesive dressings individually wrapped,

(ii) 4 sterile gauze pads, 3 inches square,

(iii) 2 rolls of gauze bandage, 2 inches wide,

(iv) 2 field dressings, 4 inches square or 2 four-inch sterile bandage compresses, and

(v) 1 triangular bandage.

(2) The employer shall ensure that the first aid station is at all times in the charge of a worker who,

(a) is the holder of a valid St. John Ambulance Emergency First Aid Certificate or its equivalent; and

(b) works in the immediate vicinity of the station.

9 (1) Every employer employing more than five workers and not more than fifteen workers in any one shift at a place of employment shall provide and maintain a first aid station with a first aid box containing as a minimum,

(a) a current edition of a standard St. John Ambulance First Aid Manual;

(b) 1 card of safety pins; and

(c) dressings consisting of,

(i) 24 adhesive dressings individually wrapped,

- (ii) 12 sterile gauze pads, 3 inches square,
- (iii) 4 rolls of 2-inch gauze bandage,
- (iv) 4 rolls of 4-inch gauze bandage,
- (v) 4 sterile surgical pads suitable for pressure dressings, individually wrapped,
- (vi) 6 triangular bandages,
- (vii) 2 rolls of splint padding, and
- (viii) 1 roll-up splint.

(2) The employer shall ensure that the first aid station is at all times in the charge of a worker who,

- (a) is the holder of a valid St. John Ambulance Standard First Aid Certificate or its equivalent; and
- (b) works in the immediate vicinity of the box.

10 (1) Every employer employing more than fifteen and fewer than 200 workers in any one shift at a place of employment shall provide and maintain at the place of employment one stretcher, two blankets and a first aid station with a first aid box containing as a minimum,

- (a) a current edition of a standard St. John Ambulance First Aid Manual;
- (b) 24 safety pins;
- (c) 1 basin, preferably stainless steel; and
- (d) dressings consisting of,
 - (i) 48 adhesive dressings, individually wrapped,
 - (ii) 2 rolls of adhesive tape, 1 inch wide,
 - (iii) 12 rolls of 1-inch gauze bandage,
 - (iv) 48 sterile gauze pads, 3 inches square,
 - (v) 8 rolls of 2-inch gauze bandage,
 - (vi) 8 rolls of 4-inch gauze bandage,

- (vii) 6 sterile surgical pads suitable for pressure dressings, individually wrapped,
 - (viii) 12 triangular bandages,
 - (ix) splints of assorted sizes, and
 - (x) 2 rolls of splint padding.
- (2) The employer shall ensure that the first aid station is at all times in the charge of a worker who,
- (a) is the holder of a valid St. John Ambulance Standard First Aid Certificate or its equivalent; and
 - (b) works in the immediate vicinity of the box.

First Aid Room

- 11 (1) Every employer employing 200 or more workers in any one shift at a place of employment shall provide and maintain a first aid room equipped with,
- (a) a current edition of a standard St. John Ambulance First Aid Manual;
 - (b) instruments consisting of,
 - (i) dressing scissors,
 - (ii) dressing forceps,
 - (iii) safety pins,
 - (iv) graduated medicine glass,
 - (v) tongue depressors, and
 - (vi) applicators, cotton-tipped;
 - (c) denatured ethyl alcohol;
 - (d) dressings consisting of,
 - (i) adhesive dressings, individually wrapped,
 - (ii) sterile gauze pads of assorted sizes, individually wrapped,
 - (iii) gauze bandages of assorted sizes,
 - (iv) adhesive plaster,
 - (v) absorbent cotton,
 - (vi) triangular bandages,
 - (vii) splints of assorted sizes, and
 - (viii) splint padding; and
 - (e) furnishings consisting of,
 - (i) hot and cold running water,
 - (ii) 3 washbasins, preferably stainless steel,
 - (iii) 1 instrument sterilizer,

- (iv) 1 cabinet for surgical dressings,
 - (v) 1 enamel foot bath,
 - (vi) 1 sanitary disposal receptacle with lid,
 - (vii) 1 first aid box containing as a minimum the items required by subsection 9 (1), for use by the attendant at the scene of an accident before the patient is moved to the first aid room or general hospital,
 - (viii) 1 couch curtained off or in a separate cubicle,
 - (ix) 1 stretcher, and
 - (x) 2 blankets.
- (2) The employer shall ensure that the first aid room is in the charge of,
- (a) a registered nurse; or
 - (b) a worker who,
 - (i) is the holder of a valid St. John Ambulance Standard First Aid Certificate or its equivalent,
 - (ii) works in the immediate vicinity of the first aid room, and
 - (iii) does not perform other work of a nature that is likely to affect adversely his or her ability to administer first aid.
- (3) The certificate referred to in subclause (2)(b)(i) shall be prominently displayed in the first aid room.
- 12 Where the first aid station referred to in section 9 or 10 or the first aid room referred to in section 11 is not easily accessible in order to provide prompt treatment of any worker, an additional first aid station or stations shall be established to comply with subsection 1(3).

**Transportation, Construction,
Farm and Bush Sites**

- 13 For the purposes of section 8, 9, 10 and 11,
- (a) a railway train, vessel or bus on a route, other than an urban or suburban route, on which a worker is employed;
 - (b) the central point from which bush workers are dispatched daily to work sites;
 - (c) a vehicle being used by an employer to transport workers; or
 - (d) the site of the construction, repair or demolition of a building, shall be deemed to be a place of employment.
- 14 (1) Where the place of employment is the site of construction, repair or demolition of a building, a first aid station shall be maintained in the time office for the project.
- (2) Where there is no time office for the project, a first aid station shall be maintained in a vehicle or building at the site and section 1 applies.
- 15 Where the construction, repair or demolition of a building is in the charge of a general contractor, the general contractor shall provide and maintain the first aid station or stations required by this Regulation in respect of the workers in the same manner as if the general contractor were the employer of the workers.
- 16 (1) Every employer of bush workers or farm workers, or both, shall provide at a central location a first aid box containing,
- (a) a current edition of a standard St. John Ambulance First Aid Manual;
 - (b) 1 card of safety pins;
 - (c) dressings consisting of,
 - (i) 16 adhesive dressings, individually wrapped,
 - (ii) 6 sterile gauze pads, 3 inches square,

- (iii) 4 rolls of 3-inch gauze bandage,
 - (iv) 2 sterile surgical pads suitable for pressure dressings, individually wrapped, and
 - (v) 4 triangular bandages.
- (2) Every employer using a vehicle to transport workers shall equip the vehicle with a first aid box containing,
- (a) a current edition of a standard St. John Ambulance First Aid Manual;
 - (b) 1 card of safety pins;
 - (c) dressings consisting of,
 - (i) 16 adhesive dressings, individually wrapped,
 - (ii) 6 sterile gauze pads, 3 inches square,
 - (iii) 4 rolls of 3-inch gauze bandage,
 - (iv) 2 sterile surgical pads suitable for pressure dressings, individually wrapped, and
 - (v) 4 triangular bandages.
- (3) The employer of workers engaged in transporting goods outside an urban area in a vehicle shall equip the vehicle with a first aid kit containing,
- (a) a current edition of a standard St. John Ambulance First Aid Manual;
 - (b) dressings consisting of,
 - (i) 12 adhesive dressings, individually wrapped,
 - (ii) 1 four-inch bandage compress,
 - (iii) 2 two-inch bandage compresses, and
 - (iv) 1 triangular bandage.

- (4) Where a worker is operating heavy construction and maintenance equipment in a place where a first aid station is not readily available to him or her in the event of an accident, the employer shall equip the machinery with a first aid kit containing the items required by subsection (3).
- (5) A bus operated on a route other than an urban route shall be equipped with a first aid kit containing the items required by subsection (3).
- (6) Motive power units of all railways other than units used in yard service shall be equipped with a first aid box equipped with the items required by subsection (2).

Guidelines for Contents of First Aid Boxes

All places of employment must have workers trained in first aid and first aid boxes with the equipment they need to offer first aid service quickly and safely.

Sections 8, 9, 10, 11 and 16 of Regulation 1101 list the items that must be included in the first aid boxes in workplaces of different types and sizes. The quantities of any item specified may be increased to suit the needs of a particular workplace. Personal protective equipment (for example, CPR mask and non-latex gloves) as prescribed by the first aid training should also be included in the first aid box. In a location where a physician or registered nurse is available, the employer may authorize them to expand the contents of the first aid boxes.

Equipment outside of the scope of first aiders, equipment that may deteriorate or that is potentially dangerous (for example, medication and ointments) should not be included in a first aid box.

Section 6 of the Regulation requires that the boxes and their contents be checked regularly, minimum four times a year, to ensure that everything is in good order.

Display of Poster

The poster entitled *In Case of Injury at Work* (Form 82) must be displayed at the first aid station as required by Section 1 of the Regulation.

The poster outlines the responsibilities and obligations of both employer and worker when an accident occurs on the job. Supplies of the poster, in various sizes, are available free on request from any WSIB office. For the office nearest you, please refer to the WSIB Web site – www.wsib.on.ca.

In All Cases of Injury/Disease**The worker must:**

1. Get first aid right away.
First aid includes but is not limited to: cleaning minor cuts, scrapes or scratches; treating a minor burn, applying bandages and/or dressings, cold compress, cold pack, ice bag, splint, changing a bandage or a dressing after a follow-up observation visit and any follow-up for observation purposes only.
2. Tell the employer of any injury or the possible onset of a work-related disease/condition.
3. Claim benefits if the injury causes him or her to seek health care. Health care includes services requiring the professional skills of a health care practitioner (i.e., a doctor, nurse, chiropractor or physiotherapist); services provided at hospitals and health facilities and prescription drugs.
The worker should also claim benefits if the injury causes him or her to:
 - Be absent from regular work
 - Require modified duties at less than regular pay
 - Require modified work at regular pay for more than seven calendar days after the date of accident
 - Earn less than regular pay at regular work.
4. Claim WSIB benefits by:
 - Signing WSIB Form 1492, the *Workers' Claim/Consent Form*, and giving a copy of the form to the employer or
 - Signing WSIB Form 6, *Worker's Report of Injury/Disease* and giving a copy of the form to the employer.
5. Choose a doctor or other qualified health professional. Do not change health professionals without permission from the WSIB.

6. Cooperate in health care treatment.
7. Cooperate in safe return to work.
8. Complete and return all WSIB forms promptly.
9. Report to the WSIB any changes in income, return to work status or medical condition.

The employer must:

1. Make sure first aid is given immediately. First aid includes but is not limited to: cleaning minor cuts, scrapes or scratches; treating a minor burn, applying bandages and/or dressings, cold compress, cold pack, ice bag, splint, changing a bandage or a dressing after a follow-up observation visit and any follow-up for observation purposes only.
2. Make sure there is a record of the first aid treatment/advice given to the worker.
3. Complete and give to the worker the *Treatment Memorandum Form 156* if the worker needs more than first aid treatment/advice.
4. Provide immediate transportation to a hospital, a doctor's office, or the worker's home, if necessary.
5. Complete WSIB Form 7, *Employer's Report of Injury/Disease*, if the worker gets health care. Health care includes services requiring the professional skills of a health care practitioner (i.e., a doctor, nurse, chiropractor or physiotherapist); services provided at hospitals and health facilities and prescription drugs.
He or she should also complete WSIB Form 7, *Employer's Report of Injury/Disease* if the injury causes the worker to:
 - Be absent from regular work
 - Require modified duties at less than regular pay
 - Require modified work at regular pay for more than seven calendar days after the date of accident
 - Earn less than regular pay at regular work.

6. Ask the worker to sign WSIB Form 1492, the *Workers' Claim/Consent* Form.
7. Return the completed Form 7 to the WSIB within three days of learning of the reporting obligation. If the worker is unable or unwilling to sign, send the form in without the signature.
8. Pay full wages and benefits for the day or shift on which the injury occurred.
9. Cooperate in the worker's early and safe return to work.
10. Supply a Functional Abilities Form 2647 to the health professional treating the worker. Ensure that the worker's signed consent to the release of the functional abilities information is attached. This signed consent will either be on the Form 1492 or the employer's copy of the Form 6.

The Employers' Report of Injury/Disease (Form 7)

Form 7 must be completed and sent to the WSIB within three days of learning of a work-related injury or occupational disease that either causes a worker to: be absent from their regular work; require modified duties at less than regular pay; earn less than regular pay at regular work; require modified duties at regular pay for more than seven calendar days; and/or obtain health care. For the WSIB office nearest you please see our Web site at www.wsib.on.ca.

Send Form 7s and all claims-related documentation to:

Workplace Safety and Insurance Board
200 Front Street West
Toronto ON M5V 3J1

– OR BY FAX –

Toll-free: 1-888-313-7373
Toronto area: (416) 344-4684

First Aid Training for Workers

Regulation 1101 requires all employers to ensure that first aid boxes and stations are in the charge of workers who hold valid first aid certificates issued by a training agency recognized by the Board.

Employers should arrange for first aid training directly with the recognized training organization of their choice.

**For the most current list of recognized providers
please see our [Web site](#) at**

www.wsib.on.ca



www.wsib.on.ca

WSIB
ONTARIO
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Workplace Safety &
Insurance Board

Commission de la sécurité
professionnelle et de l'assurance
contre les accidents du travail



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MEETING 2

The Basics: All About Small Engines

Meeting Objective: *to learn the basic elements of a small engine and encourage proper care, maintenance and practices*

Suggested Roll Calls

- Name a tool used while working on small engines.
- Name a way to keep yourself and others safe while working on small engines.
- Name a part of the body at risk while working on small engines, and how to -protect it.

Suggested Meeting Agenda (2.5 hrs.)

Welcome, Call to Order & Pledge		5 min
Roll Call		5 min
Club Business/Parliamentary Procedure	Reports, updates and new club business. Review Record Books and discuss any questions.	10 min
Topic Information Discussion	Discuss small engine basics and compare two-stroke vs. four-stroke engines. Ignition trouble-shooting should also be reviewed.	20 min
Activity Related to Reference Material	Activity #2 - Engine Parts	30 min
	Activity #3 - Nameplate Investigation	10 min
	Activity #6 - Ignition Troubleshooting: Mix and Match	30 min
Public Speaking	Activity #8 - Prop Talk	20 min
Clean up/ Adjourn	Remind members to bring their tools, supplies and equipment needed for the next meeting.	10 min
Social Time / Snacks		10 min

TOPIC INFORMATION

How an Engine Works: FAQ

What is an engine?

An engine is a device that converts energy into mechanical force or motion, using fuel.

When were engines invented?

Combustion has been around for as long as fire has existed. However, the internal combustion engine was invented in the 1600's. Although engines have become more complex, and have been used to power many different machines, their basic design and operation has not changed in several hundred years.

What is combustion?

Combustion is a type of burning that is meant to produce some sort of power. It can be external, meaning that it occurs outside the engine, but this type of combustion wastes a lot of the energy. Steam engines, volcanoes and even campfires are all examples of external combustion. Small engines use internal combustion, or a way to contain the burning within the machine, so that the energy may be harnessed and used to power the machine.

How does combustion happen?

All types of combustion require some sort of combustible material (such as fuel), as well as oxygen and heat. With internal combustion, power is produced by creating controlled explosions inside a container, such as a cylinder. Small engines use gasoline as combustible material. The carburetor mixes gasoline with oxygen, and this mixture is ignited by heat produced by a spark plug.

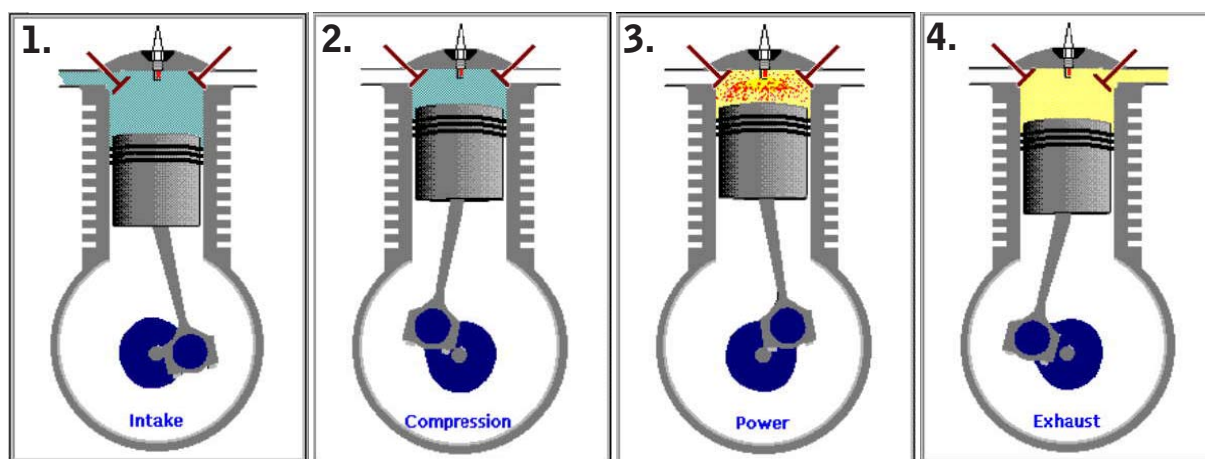


What happens after combustion occurs?

In order to keep an engine running continuously, four things must occur over and over again. Completing all four parts is called a cycle.

1. Intake is the suction of the fuel-air mixture into the cylinder where combustion occurs.
2. Compression is the forcing and keeping of the fuel-air mixture in a small space.
3. Power or heat must be applied to the mixture in order to create the explosion.
4. Exhaust is the letting go of burned gases.

Pistons inside a cylinder are moved by this process. These pistons are attached to a crankshaft that moves other parts. See next page for diagrams.



**Images from Manitoba 4-H Operation & Maintenance of Small Engines*

Can engines run on anything else?

Gasoline is the most common type of combustible material for engines, but some also run on diesel, hydrogen, methane and propane. Other types of fuels are being developed all the time. Some new engines are even being designed to run on water!

Engine Parts and their Functions

A **cylinder** is the part in which the mixed fuel and air are burned. It is usually round with smooth edges, and has a spot on top that attaches to the spark plug.

Pistons are round pieces with flat tops. They move up and down inside the cylinder and push down on the ignited fuel/air mixture.

Compression rings are specially-shaped rings used to seal the combustion chamber. Engines usually use two or three per piston.

A **connecting rod** is the part connects the piston to the crankshaft, and transfers the energy from combustion to the crankshaft. This causes the rotary motion of the engine.

A **wrist/piston pin** holds the connecting rod to the piston.

A **crankshaft** has two levels. The connecting rod attaches to the small shaft in the middle, with counterweights on the opposite side to balance it. The end of the crankshaft sticks out of the engine, and may be attached to blades, pulleys and other parts.

4-cycle engines use **intake** and **exhaust valves** to allow fuel to enter the cylinder, and to allow exhaust gases to leave it. These open up once per revolution.

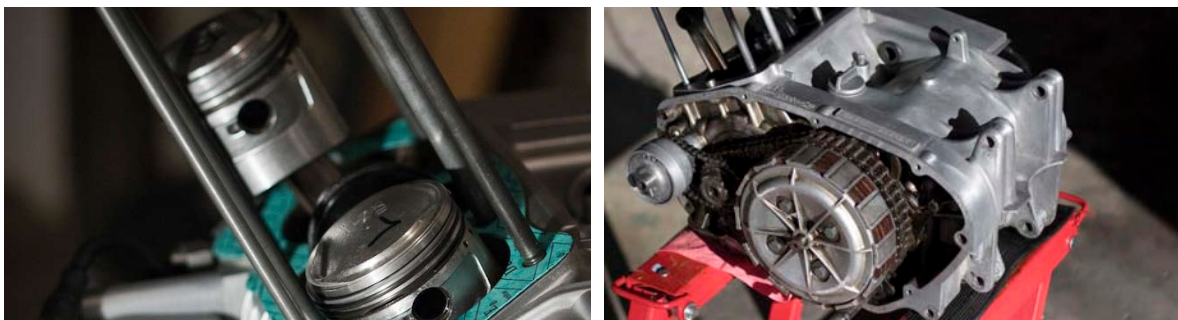
The **camshaft** is the part attached to the crankshaft that pushes valves open.

Valve springs hold the valves closed tightly.

Gears are the parts connected to the camshaft and crankshaft, with large teeth that mesh together and transfer energy from one shaft to the other.

Lobes are bumps on the camshaft that push valve tappets. The tappets open up the valves.

A **flywheel** is a heavy wheel mounted on one end of the crankshaft that keeps the piston rising and falling smoothly. It pushes the piston up on the compression stroke, and also serves as a cooling fan.



Images by Scott Pargett [_http://creativecommons.org/licenses/by/2.0/](http://creativecommons.org/licenses/by/2.0/)

Two-Stroke Engines

A two-stroke engine can produce a great deal of power for its size, but also uses a great deal more gasoline and oil, and can be more polluting. For these reasons, they're more likely to be used in smaller devices such as these.

- Lawn and garden equipment (chain saws, leaf blowers, trimmers, etc.)
- Dirt bikes
- Mopeds
- Jet skis
- Small outboard motors

Parts of a Two-Stroke Engine

Piston - a cylindrical metal piece that fits in the cylinder of the engine and moves up and down.

Reed valve - allows fresh air and fuel to be drawn into the crankcase from the carburetor. This part traps the air and fuel and acts as a check valve.

Spark plug - allows a spark to jump across a small gap to ignite fuel.

Combustion chamber - is the area in the chamber in which the fuel and air is compressed and burned. The size of the combustion chamber changes as the piston moves up and down.

Exhaust outlet - allows the exhaust waste to exit.

Cooling fins - allow air to flow around the outside of the combustion chamber. Most two-stroke engines are air-cooled.

What Makes a Two-Stroke Engine Unique?

- A two-stroke engine has no moving valves.
- The spark plug fires each time the piston hits the top of its cycle.
- There is space above the piston (combustion chamber) and below the piston (crankcase). Fresh gases sit above the piston and are ignited above the piston.
- The crankcase is used to hold the mixture of gases for the combustion chamber, instead of using it as an oil reservoir. Because of this, oil must be mixed into the gas. Manufacturers provide instructions concerning the gas to oil ratio.

How Does a Two-Stroke Cycle Work?

- During intake, an air/fuel mixture enters the crankcase and is trapped there by the one-way reed valve. A hole in the lower part of the cylinder wall lets gas and air into the combustion chamber.
- These gases are compressed as the piston moves up. A venturi creates an area of low pressure below the piston, causing fresh air and fuel to be sucked inside.
- The gasses are ignited by the spark plug, and the piston is pushed down, compressing the air/fuel mixture into the crankcase.
- Exhaust waste exits through another hole in the cylinder. Air pressure differences cause the fresh gases to flow into the cylinder and push the exhaust fumes out.

What Are the Advantages of Two-Stroke Engines?

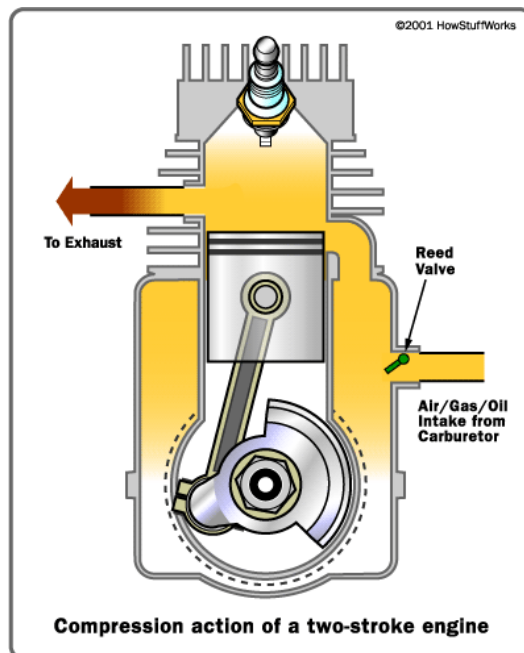
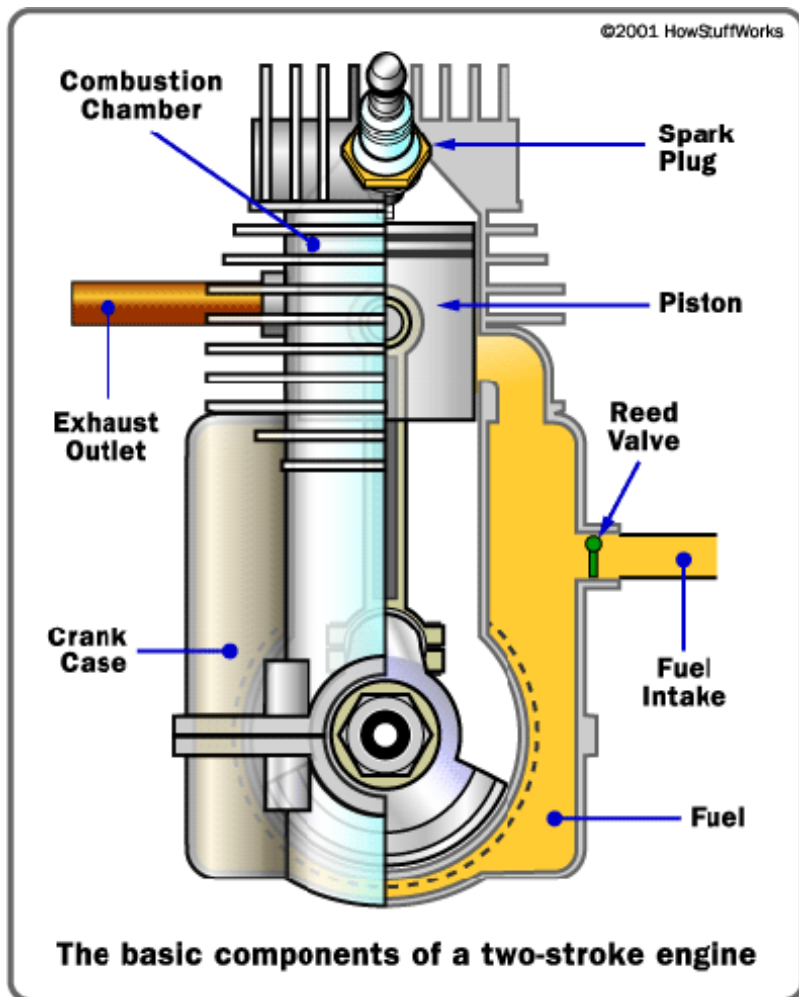
1. They do not have valves, and they have a simpler construction.
2. They fire once every revolution, instead of every other revolution.
3. They are lighter and cost less to manufacture.
4. They have the potential for about twice the power in the same size. This is because there are twice as many power strokes per revolution.

What Are the Disadvantages of Two-Stroke Engines?

1. They don't last as long as four-stroke engines. They don't have a lubrication system; making the parts wear out faster, and they require a mixture of oil and gas in order to lubricate the crankshaft, connecting rod and cylinder walls.
2. Oil for these engines can be expensive. The mixing ratio is about 4 ounces per gallon of gas, and this burns approximately one gallon of oil for every thousand miles (approximately 1600 kilometres).
3. They do not use fuel efficiently, and they yield fewer litres per kilometre.
4. They produce more pollution.
5. They combust oil within the gas, making them smoky, especially if an older model.
6. The air/fuel mixture leaks out through the exhaust port each time it is loaded into the combustion chamber.

**Adapted from the Manitoba 4-H Small Engines Member's Manual.*

Two-Stroke Engine Diagrams



**Images from www.wikimedia.org*



Four-Stroke Engines

Devices that use four-stroke engines include:

- Automobiles (cars, trucks)
- Industrial machines (generators)

Parts of a Four-Stroke Engine

Camshaft - pushes open the intake and exhaust valves.

Tappet or valve lifter - part of the pushrod-rocker arm assembly. Built with small rods with one flat end that fits on the bottom end of the pushrod. These rods come into contact with the eccentric lobe of the camshaft, and push the valve open.

Valve spring - closes intake and exhaust valves by spring action.

Spark plug or glow plug - lets a spark jump across a small gap and ignite the fuel.

Exhaust port - allows exhaust waste to exit.

Piston - a cylindrical metal piece that fits in the cylinder of the engine and moves up and down.

Crankcase - the storage unit for oil that sits inside the engine.

Crankshaft - the rotating, main shaft in an engine which is rotated by the piston and connecting rods.

Connecting rod or conrod - connects the piston to the crankshaft. It rotates at both ends so that its angle can change as the piston moves and the crankshaft rotates.

The Big end - part of the connecting rod attached to the crankshaft.

The Little end - the connection of the connecting rod to the piston.

Wrist pin or gudgeon pin - the inner part of the little end. It is a steel pin that goes through the piston.

Cylinder or liner - cylindrical holes cast into the engine block. Their numbers vary from one to twelve.

Combustion chamber - the cavity in the cylinder where the fuel and air are compressed and burned. The size of the chamber changes as the piston moves up and down.

Intake port - the pipe or tube that brings the fuel/air mixture from the carburetor into the cylinder for combustion.

Intake valve - opens and closes a hole in the cylinder head and lets in fuel from the carburetor. The moment in which this happens is called the intake stroke.

What Makes a Four-Stroke Engine Unique?

- These engines are water-cooled. Water surrounds the cylinder, and is circulated around the motor using a pump. The water flows into a radiator, and tiny fins release the heat into the air. The water is then moved back into the motor to repeat the cycle. This circulation draws heat from the engine.
- The gasoline and oil are kept separate. These engines are lubricated by oil from a separate oil reservoir, and a gear pump delivers it to different places in the engine. This makes separate oil changes necessary.

How Does a Four-Stroke Cycle Work?

- During the intake stroke, the intake valve is open, the piston is moving down, and a mixture of air and vaporized fuel is drawn into the cylinder from the carburetor, through the intake port.
- During the compression stroke, the piston begins to move upward. The intake and exhaust valves are closed and the cylinder is sealed. The air/fuel mixture is compressed as the piston moves upward.
- During the power stroke, the piston reaches the top of the stroke, and the spark plug ignites the air/fuel mixture. The explosion creates expanding exhaust gases that force the piston downward for the third stroke, and this force is converted into power, turning the crankshaft and the flywheel. This motion is converted by the energy of converting fuel energy into mechanical energy.
- In the exhaust stroke, the piston reaches the bottom of its travels, the exhaust valve opens, and the piston moves up, pushing the exhaust gases out of the cylinder. When the piston reaches the top of its stroke, the exhaust valve closes, and the intake valve opens. The cycle repeats again with the intake stroke, using energy left in the flywheel to start the four strokes again.

What Are the Advantages of a Four-Stroke Engine?

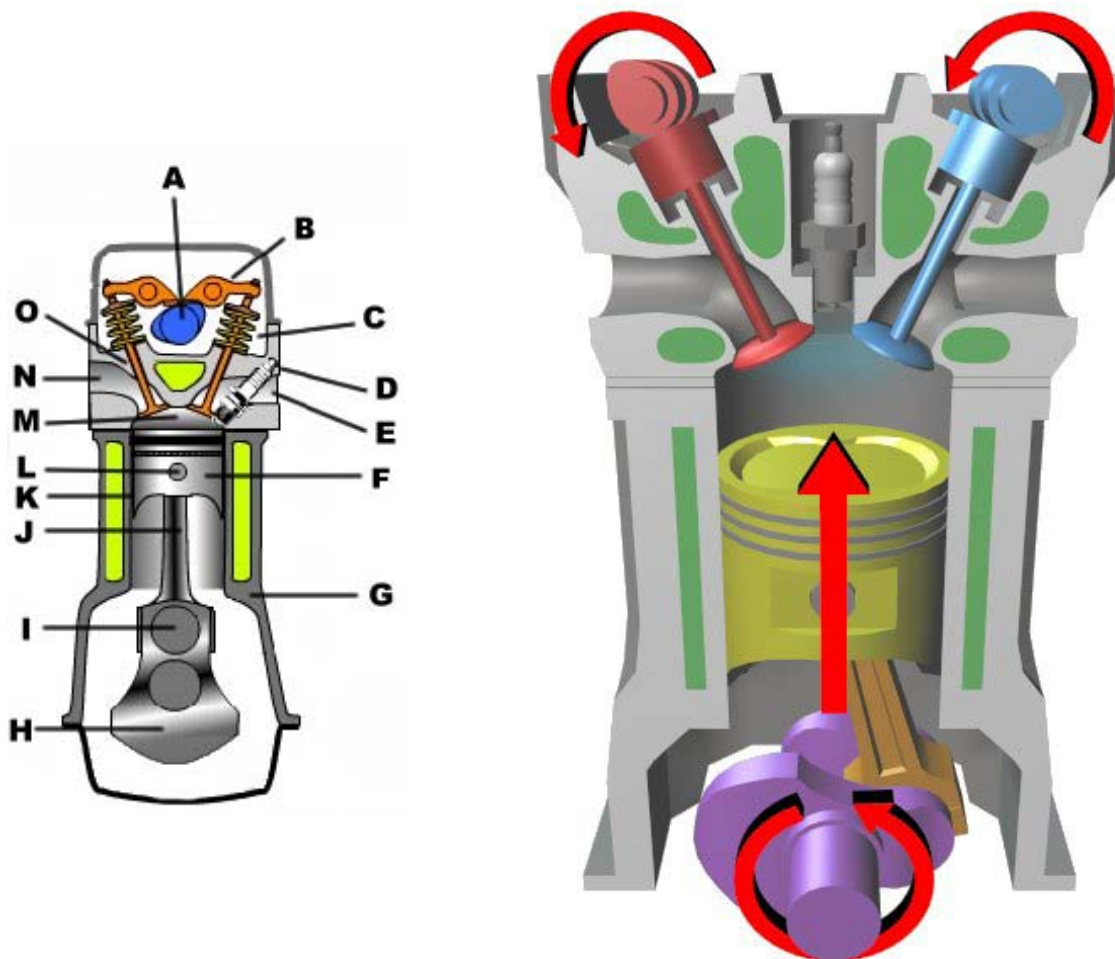
1. It is more efficient than a two-stroke engine.
2. It pollutes less.

What Are the Disadvantages of a Four-Stroke Engine?

1. It has more moving parts than a two-stroke engine, making it more complex, expensive and difficult to manufacture and maintain.

**Adapted from the Manitoba 4-H Small Engines Member's Manual.*

Four-Stroke Engine Diagrams

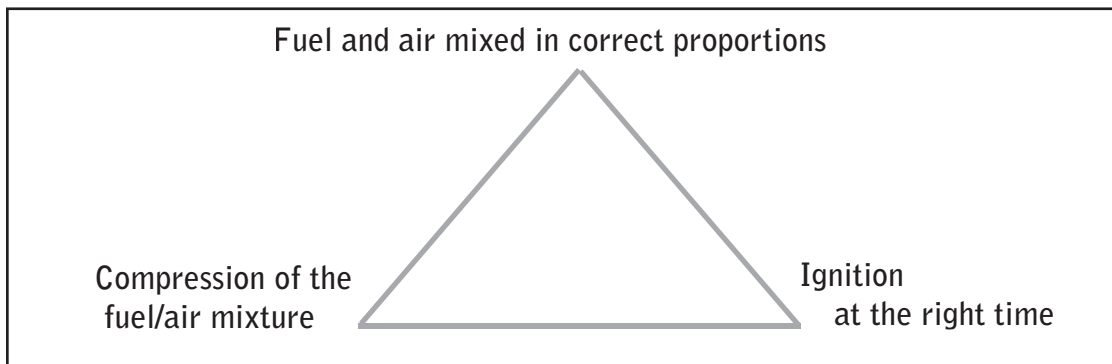


- A - Camshaft: opens and closes the valves
- B - Tappet: pushed by the camshaft, moves the valves
- C - Valve spring: keeps the valve normally shut
- D - Spark plug (or glow plug in a diesel)
- E - Exhaust port: where waste fuel is pushed out
- F - Piston
- G - Crankcase
- H - Big end
- I - Crankshaft: turned by the piston - turns the engine and makes the car go
- J - Connecting rod (or Conrod or just rod)
- K - Cylinder
- L - Wrist pin (or Gudeon pin): attaches piston to conrod
- M - Combustion chamber: where the fuel explodes
- N - Inlet port
- O - InletValve

**Images from www.wikimedia.org*



What Does an Engine Need to Run?



** From the Alberta 4-H Small Engines Member's Guide.*

Ignition Troubleshooting

Things to Check:

1. Tightness of spark plugs
2. Tightness of cylinder head bolts
3. Connected/disconnected spark plug wire
4. Turning power of flywheel
5. Compression capabilities
6. Air leaks
7. Hot spots
8. Condition of piston rings and cylinder walls
9. Wear in cylinder and piston ring

Troubleshooting Flowchart

Will the engine start?

↓No

Spark plug malfunction? → Yes → Replace the spark plug

↓No

Magneto points burned or maladjusted? → Yes → Install new points & set gap

↓No

Coil air gap maladjusted? → Yes → Reposition coil to get correct air gap

↓No

Crankshaft key sheared/partially sheared? → Yes → Replace key & check ignition



Tips for Proper Care and Handling

Before/after working on an engine:

- Transport an engine carefully to different locations.
- Keep the engine away from damaging weather conditions.
- Store the engine in a location where it won't be damaged or harm others.

While working on an engine:

- Check the oil levels before use.
- Clean the engine on a regular basis.
- Check for worn parts and leaks regularly.
- Work on the engine on a stable work surface.
- Warm up the engine before applying a load.
- Stop the engine if a problem is suspected.
- Check for obstacles in the way of the engine.
- Use the engine within load and speed limits.
- Let the engine cool off before shutting it off.

Why worry about proper storage?

- Leaving an engine exposed to elements such as extreme cold, heat or moisture can cause damage.
- Leaving gasoline and oil in the engine for long periods of time can cause it to clog up the engine.
- Excess moisture left in the engine, or dirt or chemicals left on the engine may cause rust or corrosion.

Off-Season Storage

1. Remove fuel from the tank.
2. Start the engine and make sure all fuel in the carburetor and the line is used up.
3. If the engine starts to sputter, use the choke lever to drain the carburetor.
4. Remove the carburetor bowl and clean it thoroughly before replacing.
5. Remove the spark plug and add one teaspoon of SAE 10W lubricating oil to the cylinder. Cranking the engine several times will make sure it's well-distributed. Stop the engine when it is at the top of a stroke, and replace the plug.
6. Make sure the outside of the engine, including the cooling fins on the cylinder and head are clean, and then service the air cleaner.
7. Apply grease or heavy oil to all exposed, unpainted parts.
8. If a complete overhaul is necessary, take it to a service centre during the off season.
9. Protect the engine from bad weather and cold by storing it inside a building.

**Adapted from the BC 4-H Mechanics Unit II*

ACTIVITIES

Activity #1: An Insider's View: How Engines Work (30 min)

Basic Engine Operations - *To examine the basic functions and operations of a small engine, including the process of combustion.*

Materials/Resources: • “How Engines Work: The Important Stuff” Worksheet • Diagrams of engines
• Sample engines (various types and models)

This worksheet may be completed individually, or as a group. To ensure that members associate theory with practice, this activity should be done with an engine, so that they may look at actual parts and functions. Senior or more experienced members may wish to take this page home the week before, or treat it as a quick review.

This activity may be supported by a variety of audio/visual materials, particularly with reference to the process of combustion. Members could be encouraged to bring or create their own diagrams.

1. What makes an engine run?
2. What are the different types of combustion?



Activity #2: Engine Parts! (30 min)

Basic Engine Parts - *To identify and examine the basic parts of two-stroke and four-stroke engines.*

Materials/Resources: • “Small Engine Parts, and Owners’ Information Checklists”
• Posters and Diagrams • Sample engines (various types and models)

Work with the group by going through the different parts of a small engine. Discuss both two-stroke and four-stroke engines parts. This worksheet may be completed individually, or as a group. Have each member identify the parts they know and then initial beside each part. This will help members identify all the parts they still need to learn. To ensure that members associate theory with practice, this activity should be done with an engine, so that they may look at actual parts and functions. Senior or more experienced members may wish to treat this activity as a quick review. Have the members label diagrams of engines or have them lay out and label actual engine parts with sticky notes.

This activity may be supported by a variety of audio/visual materials, particularly with reference to the process of combustion. Members may be invited to bring or create their own diagrams. By the end of the project members should be able to identify the number of parts appropriate for their age level.

Junior Members: 15 Parts Senior Members: 30 Parts

Alternately, teams can work together labelling the parts on an intact engine or on parts laid out separately, with sticky notes.



HOW ENGINES WORK: THE IMPORTANT STUFF

1. What does “combustion” mean? Give three examples.
2. Why is combustion so important to a small engine?
3. What’s the difference between “internal” and “external” combustion engines? Give two examples of each.
4. What three things do you need for combustion? How do they work together?
5. What four things must happen over and over again in order for an engine to run continuously?



SMALL ENGINES PARTS CHECKLIST

Can you locate all of the important parts of a small engine?

Part	Leaders Initials/ Date	Part	Leader's Initials/ Date
Air Cleaner		Muffler	
Air Filter		Oil Filter Plug	
Battery		Oil Filter	
Blower Shroud		Oil Sump	
Cam		Piston	
Camshaft		Piston Rings	
Carburetor		Sediment Bowl	
Choke Valve		Spark Plug - Entire	
Cooling Fins		Spark Plug - Electrodes	
Crankcase Breather		Speed Control Lever	
Crankshaft		Starter - Electric Type	
Cylinder		Starter - Rope Rewind Type	
Dipstick		Starter - Rope Wind Type	
Exhaust Port		Starter- Windup Type	
Exhaust Valve		Throttle Linkage	
Flywheel		Valve- Butterfly (throttle)	
Fuel Strainer		Valve- Carburetor	
Fuel Tank		Valve- Crankcase Breather	
Gasket (various)		Valve- Fuel Shutoff	
Idle-Mixture Adjustment Valve		Valve- Reed Type	
Ignition Switch		Valve Springs	
Jets		Venturi	
Manifold- Exhaust		Wing Nut	
Manifold- Intake		Wire Ball	

**Chart adapted from the Saskatchewan 4-H Small Engines Member's Manual.*



Activity #3: Nameplate Investigation (10 min)

Nameplate Information Identification - *To identify engine nameplates, and understanding the importance of its' information*

Materials/Resources: • “Nameplate Checklist” Sheet • Members’ Record Books
• Older/worn nameplates • Chalk, charcoal or another transferring material

Use chalk or other methods to bring out information on an older nameplate. Discuss the information found on a nameplate and its importance. Have each member record the information, from the engine they are working on, onto the worksheet and in their Record Books. This can be completed individually, or as a group.

Members can be encouraged to create their own diagrams of where the important information of a nameplate is found.

1. How does this information help when working on a small engine?

Activity #4: Types of Engines (30 min)

Two-stroke and Four-stroke Cycle Engines - *To identify the difference between these two types, as well as various uses for each.*

Materials/Resources: • “Types of Engines” Worksheet (one for both age levels)
• Diagrams of two-stroke and four-stroke engines
• Examples of both types of engines

With the aid of the worksheet provided, members research on the internet, or in print resources for the answers. When members, take up the worksheet, using enlarged diagrams and/or actual engines. If possible, have examples of both two-stroke and four-stroke available, and allow members to examine them safely. If you feel comfortable doing so, you may ask senior members with previous experience to help you with demonstrations. To help more visually-oriented members, you may wish to refer back to the diagram of each type of engine from the previous activity.

In addition to learning about both types of engines, it is also important that members learn where to look for additional resources, and to evaluate which ones are useful. Websites may provide a large quantity of information, but members should be encouraged to use print resources as well, if only for the sake of comparison.

1. How is each type used?
2. What devices use each type?
3. Why is it necessary to have different types of engines?

NAMEPLATE CHECKLIST

In addition to being able to name and locate different parts of an engine, you also need to find and read nameplates. Every engine has a nameplate. It is a metal tag attached that contains important information about the engine. These plates contain important information about the engine that will help you find parts for it, maintain it and repair it.

Task	Leader's Initials/ Date
Find nameplate on three different engines	
Find make of engine and the name of the manufacturer	
Find model number or engine name	
Find serial number	
Find type number	
Find specification number	
Transfer above information accurately and neatly into records	
Use chalk to bring out numbers on an older nameplate	

**Chart adapted from the Saskatchewan 4-H Small Engines Member's Manual.*



Image by Scott Pargett _<http://creativecommons.org/licenses/by/2.0/>



TYPES OF ENGINES: JUNIOR WORKSHEET

Decide whether the description sounds more like a two-stroke engine, or a four-stroke engine.

Characteristic	Two-Stroke or Four-Stroke Engine?
Uses mixed fuel	
Uses straight gas	
Oil goes into a sump	
Oil goes into the fuel itself	
4 strokes per crankshaft revolution	
2 strokes per crankshaft revolution	
Uses ports and pistons to close them off, instead of a valve	
Has an intake and an exhaust valve	
More moving parts in the engine	
Simpler in design with fewer moving parts	
Lighter	
Heavier	
More pollution in exhaust gases	
Less pollution in exhaust gases	
Usually smaller	
Usually bigger	
Always has a camshaft	
Doesn't usually have a camshaft	
Usually louder	
Usually quieter	
Costs less	
Costs more	
More general maintenance required	
Less general maintenance required	
More efficient to operate	
Less efficient to operate	
Fewer moving parts	
More moving parts	
Often used in lawn mowers and chainsaws	
Used in automobiles	

**Adapted from the Saskatchewan 4-H Small Engines Member's Manual.*



TYPES OF ENGINES: JUNIOR WORKSHEET (ANSWERS)

Decide whether the description sounds more like a two-stroke engine, or a four-stroke engine.

Characteristic	Two-Stroke or Four-Stroke Engine?
Uses mixed fuel	Two- Stroke
Uses straight gas	Four- Stroke
Oil goes into a sump	Four- Stroke
Oil goes into the fuel itself	Two- Stroke
4 strokes per crankshaft revolution	Four- Stroke
2 strokes per crankshaft revolution	Two- Stroke
Uses ports and pistons to close them off, instead of a valve	Two- Stroke
Has an intake and an exhaust valve	Four - Stroke
More moving parts in the engine	Four- Stroke
Simpler in design with fewer moving parts	Two- Stroke
Lighter	Two- Stroke
Heavier	Four- Stroke
More pollution in exhaust gases	Two- Stroke
Less pollution in exhaust gases	Four- Stroke
Usually smaller	Two- Stroke
Usually bigger	Four- Stroke
Always has a camshaft	Four- Stroke
Doesn't usually have a camshaft	Two- Stroke
Usually louder	Two- Stroke
Usually quieter	Four- Stroke
Costs less	Two- Stroke
Costs more	Four- Stroke
More general maintenance required	Four- Stroke
Less general maintenance required	Two- Stroke
More efficient to operate	Two- Stroke
Less efficient to operate	Four- Stroke
Fewer moving parts	Two- Stroke
More moving parts	Four- Stroke
Often used in lawn mowers and chainsaws	Two- Stroke
Used in automobiles	Four- Stroke

**Adapted from the Saskatchewan 4-H Small Engines Member's Manual.*

TYPES OF ENGINES: SENIOR WORKSHEET

Briefly explain the differences between two-stroke and four-stroke engines.

Characteristic	Two- Stroke	Four- Stroke
Type of Fuel		
Type of Oil		
Type of Muffler		
Strokes per Crankshaft Revolution		
Method of Getting fuel/air mixture in combustion		
Methods of releasing burned gases		
Number of Moving Parts in the Engine		
Weight		
Size		
Pollution		
Camshaft		
Sound		
Initial Cost		
General Maintenance		
General Operating Efficiency		
Common Uses		



Activity #5: Checking Compression (60 min - depending on the number participants and engines)
Proper Procedures and Skills in Checking Compression - *To practice and demonstrate basic steps.*

Materials/Resources: • “Checking Compression” Checklist
• Engines and appropriate tools and equipment

This is a hands-on activity in which members not only demonstrate knowledge of various parts of an engine, but learn how to manipulate various processes related to compression. Go through the checklist before hand with the group, then follow up with each member asking them to show what they have learned. To ensure that each member has the skills necessary to work safely on an engine, it should be done individually. As a safety precaution, even older members should be expected to complete the list, but may assist younger members in their understanding.

If different models are available, members will gain an even broader understanding by working on different types.

1. What is the proper, safe way to check these functions?

Activity #6: Ignition Troubleshooting: Mix and Match (30 min)

Ignition Troubleshooting - *To develop a logical diagnostic procedure and identify strategies for repair.*

Materials/Resources: • Large index cards • Print-out of “steps”

This activity is done in small groups, and requires space on a table or floor to arrange the cards in proper sequence. Using the flow chart provided, print each card with a step of the process. Give each group a set of the cards (you may need to make several sets) and have them arrange the cards in the proper order. If possible, arrange groups with a mixture of ages, so that older members may help younger ones. To make this task more challenging, you may wish to have more experienced members write their own flow chart in advance, and use their work to teach younger members.

Flow charts are a useful way to approach technical and mechanical concepts, as they present information in a logical format, and also appeal to visual learners.

**The answer is found on page 11 of this meeting.*

1. What should you do if your engine won't start?
2. How do you diagnose these problems, and what can you do to solve them?
3. Why is it important to check things in the proper order?

CHECKING COMPRESSION CHECKLIST

What Do I Check	Leader's Initials
Tightness of spark plugs	
Tightness of cylinder head bolts	
Locate and disconnect spark plug wire	
Turn flywheel by hand until it comes to compression stroke	
Quick twist to flywheel (by hand or by manual starter)	
Assess compression	
Listen and check for air leaks	
Inspect for hot spots	
Check condition of piston rings and cylinder walls	
Check for dry cylinder walls and: <ul style="list-style-type: none"> • Remove spark plug Pour one tablespoon of oil into cylinder • Recheck compression 	
If compression continues to be low check: <ul style="list-style-type: none"> • Valve/Cylinder/ Piston Ring wear 	



Will the engine start?

YES →

YES →

Spark plug malfunction?

YES →

YES →

Magneto points burned or maladjusted?

NO ↓

Install new points and set gap.

NO ↓

Coil air gap maladjusted?

Replace the spark plug.

Reposition coil to get correct air gap.

NO ↓

Crankshaft key sheared or partially sheared?

Replace key and recheck ignition.

NO ↓

Activity #7: Remember This? Review Word Search (10 min)

General Care and Handling of Small Engines - *Review key terms and procedures surrounding care and handling of small engines.*

Materials/Resources: • Care and Handling: Review Word Search

The following word search is intended for use in reviewing key terms, concepts and skills covered by Meeting 2. You may wish to have Junior members work in groups, or find only a portion of the words.

Because members are working on engines at this point in the program, this activity can also be sent home for members to complete.

1. What are some of the most important ideas we've studied in this section?
2. What are the most important things to remember about how an engine works, types of engines, and care and handling?

Activity #8: Prop Talk (20 min)

Small Engines Parts and Tools - *To practice public speaking and develop the ability to think creatively on-the-spot*

Materials/Resources: • Various tools and small engine parts

Give six members six different small engine parts or tools. Give each of these members one minute to think of two to three creative uses for the object, other than its use in small engines. Encourage the members to think creatively not only about the use but also about his/her presentation. The objective is for each member to try and sell his/her object's creative use.

This activity helps members think quickly and creatively. It encourages them to present something on-the-spot, and learn the importance of effective communication when trying to sell ideas to others.

1. Did the prop help you feel more comfortable when speaking in front of a group?
2. What methods worked best to convince others of the new uses?

** Adapted from Alberta 4-H's Speak Pack*

CAPE AND HANDLING: REVIEW WORD SEARCH

G	A	S	K	E	T	R	V	O	E	P	U	M	R	A	W	B
L	P	C	K	P	I	A	T	I	G	N	I	T	E	E	O	L
R	I	E	R	C	O	O	S	E	A	M	M	S	X	L	L	E
A	S	N	M	O	A	W	B	A	R	A	I	H	T	M	N	E
G	C	S	T	T	C	R	E	S	O	N	A	S	C	O	L	H
N	W	O	D	L	O	O	C	R	T	U	U	E	I	D	N	W
I	C	L	M	A	I	N	N	F	S	A	E	T	I	I	T	Y
M	Y	V	D	B	D	G	A	T	H	L	C	B	N	S	N	L
I	L	E	M	S	U	H	N	X	A	E	T	L	T	P	E	F
T	I	N	O	I	S	S	E	R	P	M	O	C	E	O	M	Y
R	N	T	K	K	T	E	T	S	E	O	I	T	R	S	P	N
O	D	Q	N	R	C	X	N	I	G	L	A	N	N	A	L	R
P	E	A	O	T	O	I	I	T	O	N	F	S	A	L	U	I
M	R	K	O	E	V	L	A	V	H	N	I	F	L	T	Q	R
C	E	S	P	E	E	D	M	A	C	G	O	R	U	X	E	I
M	I	X	T	U	R	E	K	A	T	N	I	M	F	M	C	R
T	S	M	D	I	S	C	O	N	N	E	C	T	O	O	L	S

bolts
cam
combustion
compression
contaminate
cool down
cracks
crankshaft
cylinder

disconnect
dustcovers
equipment
exhaust
flywheel
gasket
ignite
inspection
intake

internal
maintenance
manual
mixture
muffler
obstacles
piston
port
solvent

speed
storage
stroke
tightness
tools
valve
warm up



CARE AND HANDLING: REVIEW WORD SEARCH (ANSWERS)

G	A	S	K	E	T	R	V	O	E	P	U	M	R	A	W	B
L	P	C	K	P	I	A	T	I	G	N	I	T	E	E	O	L
R	I	E	R	C	O	O	S	E	A	M	M	S	X	L	L	E
A	S	N	M	O	A	W	B	A	R	A	I	H	T	M	N	E
G	C	S	T	T	C	R	E	S	O	N	A	S	C	O	L	H
N	W	O	D	L	O	O	C	R	T	U	U	E	I	D	N	W
I	C	L	M	A	I	N	N	F	S	A	E	T	I	I	T	Y
M	Y	V	D	B	D	G	A	T	H	L	E	B	N	S	N	L
I	L	E	M	S	U	H	N	X	A	E	T	L	T	P	E	F
T	I	N	O	I	S	S	E	R	P	M	O	C	E	O	M	Y
R	N	T	K	K	T	E	T	S	E	O	I	T	R	S	P	N
O	D	Q	N	R	C	X	N	I	G	L	A	N	N	A	I	R
P	E	A	O	T	O	I	I	T	O	N	F	S	A	L	U	I
M	R	K	O	E	V	L	A	V	H	N	I	F	L	T	Q	R
C	E	S	P	E	E	D	M	A	C	G	O	R	U	X	E	I
M	I	X	T	U	R	E	K	A	T	N	I	M	F	M	C	R
T	S	M	D	I	S	C	O	N	N	E	C	T	O	O	L	S

bolts
cam
combustion
compression
contaminate
cool down
cracks
crankshaft
cylinder

disconnect
dustcovers
equipment
exhaust
flywheel
gasket
ignite
inspection
intake

internal
maintenance
manual
mixture
muffler
obstacles
piston
port
solvent

speed
storage
stroke
tightness
tools
valve
warm up



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MEETING 3

A Closer Look: Part One

Meeting Objective: *To explore and learn about WHAT and HOW TO keep engines clean*

Suggested Roll Calls

- Name an engine part and its function.
- Name a difference between two-stroke and four-stroke engines.
- What can happen if an engine or work space is dirty or unkept?

Suggested Meeting Agenda (2.75 hrs.)

Welcome, Call to Order & Pledge		5 min
Roll Call		5 min
Club Business/Parliamentary Procedure	Reports, updates and new club business. Review Record Books and discuss any questions.	10 min
Topic Information Discussion	Generally review engine cleaning and why it is important. The remainder of the Topic Information should be discussed in the activities.	10 min
Activity Related to Reference Material	Activity #2 - Degreasing 101: Cleaning an Engine	45 min
	Leader/ Member decided hands- on work with engines	30 min
Judging Activity	Activity #5 - Picture the Ideal	30 min
Topic Information Discussion	Discuss the importance and benefits of keeping the workspace clean and organized.	5 min
Clean up/ Adjourn	Remind members to bring their tools, supplies and equipment needed for the next meeting.	15 min
Social Time / Snacks		10 min

TOPIC INFORMATION

Keeping it Clean

To be able to properly clean an engine, the workspace used must also be clean. Keeping the workspace clean and organized not only improves safety, but also improves efficiency and reduces the risk of losing tools and parts. Cleaning up properly, disposing of waste safely, labelling tools and parts and visually inspecting the workspace before beginning work are all easy and important.

Cleaning Procedures for Various Parts:

- Pistons should be disassembled, with the rings removed. An aluminum-safe spray washer may be used, or a soak tank. After this piston tops may be glass- beaded.
- Intake valves should be soaked in a hot caustic, and buffed using a wire wheel. Stems should be polished with an appropriate grit belt, inspected for smoothness, and valves glass beaded.
- Non-hydraulic lifters may be cleaned with a hot caustic soak.
- Hydraulic lifters may be cleaned by hand with a spray carb cleaner.
- Steel rocker springs should be soaked in a hot caustic vat.
- Crankshafts should be soaked in a hot caustic vat, and may later be wire wheel buffed or bead-blasted. They may also be heat-cleaned.
- Camshafts should be cleaned using the same method as cranks, but should not be bead-blasted.
- Rockers should be cleaned in a steel media tumbler for 10-15 mins , spray washer or a soak tank. When cleaning aluminum rockers, a non-caustic hot detergent vat is recommended.
- Valve springs are cleaned in a media tumbler with solvent or spray wash or soak tank.

**"The Nitty Gritty On Small Parts Cleaning: Many Ways To Clean Small Engine Parts", by Ed Sunkin, Engine Builder Magazine, March, 1998, www.enginebuildermag.com*

Degreasing an Engine:

1. Examine the engine for leaks.
2. Remove the blower shroud.
3. Remove the air cleaner and cover the air cleaner opening.
4. Clean the exhaust system. On a two-cycle engine, remove the muffler and rotate the crankshaft so that the piston covers the exhaust port. Then clean the exhaust port with a wooden scraper, and make sure there is no carbon in the cylinder. Clean the muffler using solvent, and replace the muffler or engine. Finally, if the engine has no muffler, cover the exhaust ports.
5. Apply the solvent evenly and leave it for at least 5 minutes.
6. Remove the solvent. Use a water stream (or a soap solution) to rinse it clean (degreaser), and rinse it clean with a petroleum solvent. Be sure to clean the areas missed by the solvent.
7. Remove the protective covers on the air cleaner and exhaust parts. Replace the carburetor air cleaner.
8. Dry the engine by operating it, or by using compressed air.

The Air in There: Air Cleaners

The Importance of Air Cleaners

- In order for combustion to happen properly, there must be the correct mixture of air and fuel.
- The correct quantity of air is essential, but the correct quality of air is also necessary. Other chemicals in the air may prevent the engine from running properly.
- The air cleaner protects the engine from particles, dust and dirt. Maintaining the air cleaner also prolongs the life of the engine itself.
- Different types of engines take different types of air cleaners. Be sure to read the owner's manual for specific types.

Types of Air Cleaners

- An oil bath cleaner forces air through a bath of oil, which traps dirt particles and cleans the air. Air enters under the edge of the cover, and is directed downward to the bottom of the oil cup. The oil coats the dirt particles, and causes them to be lodged in a filtering element as the air passes through.
- An oil-filtered cleaner contains filtering material, such as aluminium foil mesh, or polyurethane sponge. These materials are coated with oil, and when the air enters the cleaner, it passes over a large area of oiled surface. Dust and dirt particles are trapped, and do not enter the engine. This type of filter must be oiled regularly in order to function properly.
- A dry-filter cleaner is made with a porous filtering element such as paper, moss or hair. Instead of trapping dirt and dust in oil, this type of filter contains only very small openings so these particles cannot pass through. Dry filters are easy to service and replace, and cause less restriction in the air passage. They are also more efficient so it's apparent when the engine needs a new one, as it stops running as effectively. Unfortunately, they are also more expensive.

Servicing Air Cleaners

- It's important to read the recommendations given by the manufacturer.
- The dirtier or dustier the conditions, the more often an air cleaner should be replaced.
- If using a machine for long periods of time or in dirty conditions, it's useful to inspect it at least once a day. Most filters require cleaning twice a day.
- It's also a good idea to carry an extra filter, as it's inconvenient to clean a filter while working.

General Guidelines

For Oil Bath Air Cleaners:

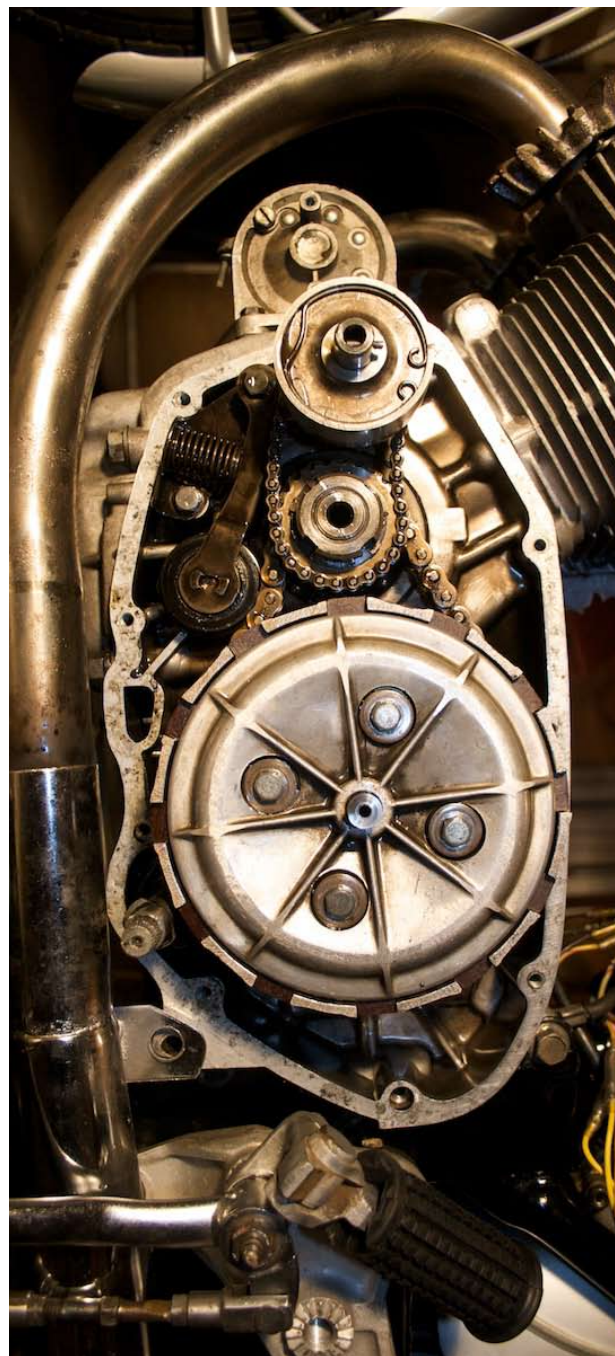
1. Disconnect the spark plug wire.
2. Loosen the cover and remove the air cleaner.
3. Cover the air intake.
4. Clean the cleaner cup.
5. Check the air intake pipe.
6. Refill the oil cup.
7. Remove the air intake cover.
8. Reassemble the air cleaner.
9. Reconnect the spark plug wire.

For Oiled Filter Air Cleaners:

1. Disconnect the spark plug wire.
2. Clean the area from around the air cleaner.
3. Remove the element cover.
4. Remove the air filter element.
5. Cover the air intake.
6. Clean the filter cover and housing.
7. Dry the filter element.
8. Clean the carburetor intake.
9. Oil the filter intake.
10. Assemble the filter element.
11. Reconnect the spark plug wire.

For Dry Filter Air Cleaners:

1. Disconnect the spark plug wire.
2. Clean the area around the air cleaner.
3. Remove the filter cover.
4. Cover the air intake.
5. Clean the filter element.
6. Clean the filter cover and air intake.
7. Assemble the air cleaner.



**Adapted from the BC 4-H Mechanics, Unit 1 and the Saskatchewan 4-H Small Engines Manual
Image by Scott Pargett _<http://creativecommons.org/licenses/by/2.0/>*

Fuel Strainers

What is a fuel strainer for?

Fuel flowing into an engine must remain clean in order for it to properly ignite. Sediment and dirt may cause damage, and it's important to have a system in place to capture it. A fuel strainer serves this purpose.

What are the different types of fuel strainers?

In some engines, fuel strainers are built into the bottom of the tank. Some models have a removable strainer built into the actual fuel line, or a disposable paper filter.

How are fuel filters serviced?

1. All fuel must be drained from the tank.
2. The sediment reservoir is located in the lowest part of the tank. Clean all sediment from this indentation.
3. Wipe any sediment from the end of the filter element.
4. Wipe the inside of the tank with a clean cloth.
5. Refill the fuel tank.

How do you clean sediment from a fuel strainer?

1. Close the shutoff valve on the fuel line.
2. Remove the sediment bowl by loosening the lock nut on the bowl retainer.
3. Empty and clean the sediment bowl and the filter screen, and then refill the bowl with fresh fuel.
4. Reinstall both, being careful to tighten the lock nut.
5. Open the shutoff valve.

How do you replace an in-line fuel filter?

1. Close the shutoff valve on the fuel line, or use a clothespin to pinch it closed.
2. Disconnect the filter from the fuel line.
3. Replace the filter with the same type and model as the original.
4. Open the shutoff valve.

<http://home.howstuffworks.com/how-to-repair-small-engines2.htm>

ACTIVITIES

Activity #1: Top 10 - Keeping it Clean (30 min)

Proper Cleaning Procedures - *To explain and illustrate the difference between effective and ineffective cleaning practices.*

Materials/Resources: • Chart paper and markers • “Keeping It Clean” Worksheet

This activity may be done individually or in small groups. It may be completed at home, or during a session. Ask each individual or group to list what they think the Top 5 Rules for Cleaning (both engines and the workspace) should be. Then have each group present their Top 5. Follow up the presentations with a discussion/ debate and have the group decide on the Ultimate Top 10 Rules for Keeping It Clean, then put them up in the shop where all members can see it when working on their engines. You may also want to hand out the following worksheet so each member can fill out and use it for their own reference.

If members are more comfortable working on a computer, or cutting and pasting pictures together, have them create a creative poster for each Rule.

1. What would a clean workspace and/or engine look like?
2. Where is appropriate protective equipment and safety equipment stored?
3. What are the proper procedures for clean up/ ways of disposing of waste safely?

Activity #2: Degreasing 101: Cleaning an Engine (45 min - possibly spread over 2 meetings)

Degreasing the Crankcase - *To identify parts of a crankcase that require cleaning and discuss proper cleaning techniques and order.*

Materials/Resources: • “Degreasing Crankcases” Checklist

This checklist is intended to help members identify proper degreasing procedures as they work on their own engines, and to enable leaders to track their progress. Ask members to keep a copy of the checklist in their Record Book. Older, more experienced members will most likely move through the list more quickly, and may be asked to help younger members practice.

To add to the breadth of knowledge (if resources are available), you may wish to have members degrease several types and models of engines. You may also wish to have them work in partners, so they can examine the workings of each other’s engines.

1. What are the parts of a small engine that require degreasing?
2. What is the proper way to degrease an engine safely?
3. Which parts should be degreased first?

OUR ULTIMATE TOP 10 RULES FOR KEEPING IT CLEAN

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.



DEGREASING CRANKCASES: A CHECKLIST

This checklist names the parts of the engine that require degreasing, and the order in which they should be cleaned. Use this checklist to keep track of your progress, and have your leader sign each part once you've learned how to do it.

Task	Leader's Initials/ Date
1. Examine your engine to see if it has any leaks.	
2. Remove the blower shroud.	
3. a) Remove the air cleaner. 3. b) Cover the air cleaner opening.	
4. Clean the exhaust system.	
If you have a two-cycle engine: <ul style="list-style-type: none"> • Remove the muffler. • Rotate the crankshaft so that the piston covers the exhaust port. • Clean the exhaust port with a wooden scraper, and make sure there is no carbon in the cylinder. • Clean the muffler using solvent. • Replace the muffler or engine. • Replace the muffler or engine. 	
5. a) Apply the solvent evenly. 5. b) Leave the solvent on for 5 minutes or longer.	
6. Remove the solvent by: <ul style="list-style-type: none"> a) Using a water stream to rinse it clean (degreaser) b) Using a soap solution, and rinsing it clean (petroleum solvent) c) Cleaning the areas missed by the solvent 	
7. Remove the protective covers on the air cleaner and exhaust parts.	
8. Replace the carburetor air cleaner.	
9. Dry the engine by operating it, or by using compressed air.	



Activity #3: The Air In There: Fast Facts on Air Cleaners (30 min)

Purpose and Function of Air Cleaners - *To identify key parts of an air cleaner and analyze its function.*

Materials/Resources:

- Chart paper and markers
- Internet Access (optional)
- Reference books and materials
- Sample parts of air cleaners
- Photos and diagrams of engine air cleaners

For this activity, divide members up by age groups and have them create a “Fast Facts” page with at least 10 pieces of information. Junior members should give a definition of an air cleaner and explain its basic purpose and function. Senior members may cover the three different types of air filters, and/or cover proper cleaning procedures, along with safety precautions and hazards. When groups have had a chance to list their facts, have them present to the group as a whole.

Compiling and summarizing facts is a skill essential for both academic and professional success. Information pages such as these may be compiled into one booklet or poster, and used as a display at the Achievement Program.

1. Why are air cleaners essential to a small engine?
2. What parts of an engine are involved in air cleaning?
3. How do these parts work?

Activity #4: Fuel Strainers: 20 Questions (30 min)

Purpose and Function of Fuel Strainers - *To identify key parts of a fuel strainer and analyze its function.*

Materials/Resources:

- Sample fuel strainers
- Paper and pens
- “Fuel Strainer Questions”

Before examining fuel strainers as a group, have members form small groups of mixed ages and write down at least 10 questions about fuel strainers that they’d like answered. Compile these questions into a master list (20 questions), As you disassemble, clean, assemble and examine actual fuel strainers in your session answer these questions. A page of sample questions has been included.

Allowing members to write down their own questions in advance encourages them to assess their previous knowledge of engines, and identify areas for which they still have questions. Combining all ages within a group allows younger members to benefit from the knowledge and experience of older members, and encourages them to ask a wider range of questions.

1. Why are fuel strainers essential to a small engine?
2. What parts of an engine connect to a fuel strainer?
3. How do these parts work?

FUEL STRAINER QUESTIONS

1. What is a fuel strainer? What does it do?
2. What parts make up a fuel strainer?
3. Are there different types of fuel strainers for different types of engines?
4. What are the steps one should take to disassemble a fuel strainer? Which parts should be disassembled first?
5. What can you do to ensure that you aren't hurt during disassembly?
6. How do you use solvent to clean a fuel strainer?
7. How can you clean a fuel strainer while dry?
8. What are the steps one should take to assemble a fuel strainer? Which parts should be assembled first?
9. What is a sediment bowl for? What does it do?
10. What are the different types of bowls that may be found in a fuel strainer?
11. How is a sediment bowl removed and cleaned? What are the proper steps to take?
12. Why is it important to drain fuel after removing the sediment bowl?
13. What role does a screen play in a fuel strainer?
14. What are the signs of wear or damage that may be found in a fuel strainer?
15. How does a spark plug relate to a fuel strainer?
16. How does the fuel line relate to the fuel strainer?
17. How often should the fuel strainer be inspected?
18. Is it expensive to replace or repair a fuel strainer?
19. Once a fuel strainer has been maintained/replaced, how can you tell if it's working?
20. What are some of the safety concerns associated with maintaining or repairing fuel strainers?



Activity #5: Picture the Ideal (Part 1 – Brainstorming [15 min] , Part 2 – Judging [15 min])
Setting Judging Standards for a Small Engine - *To identify the key elements a small engine should be judged on and begin to think about their own small engine project critically*

Materials/Resources: • Paper and pens • Sample engines
 • “Small Engines Judging Sheet”

Part 1:

Have members brainstorm qualities of a small engines project that would get a perfect score. Be sure to leave time for members to discuss their ideas, and make a master list. When they are finished distribute the Small Engines Judging Sheet and if they wish, have members add to it.

To get them started, have them discuss the following sentences:

- The ideal small engine project would look like...
- The ideal small engine project would sound like...
- The ideal small engine project would be presented like...
- I can tell if an engine is clean and well maintained when...
- I can tell if all safety measures have been taken when...
- The most important thing to look for in a small engines project is...
- I would immediately deduct points from a project if...
- A person really knows how to operate, maintain and repair a small engine when...

Part 2:

Now have members judge a class of small engines. Make sure they practice giving reasons, either to the entire group or to a leader. Have a leader or senior member give the official set of reasons.

Before members are able to judge their own work, as well as that of others, they must first learn to set standards for small engines.

SMALL ENGINES JUDGING SHEET

Perfect Score

Safety Precautions

/20

- Proper start up and shut down procedures
- Proper storage of materials and equipment
- Proper use of safety equipment
- Use of correct fuel and supplies
- Knowledge of hazards

Construction

/20

- Parts assembled correctly
- No leaks
- No loose parts
- Correct sizes and models of parts used

Cleanliness

/20

- No excess oil, grease or dirt
- Knowledge of proper cleaning methods

Running

/20

- Engine starts up and shuts down properly
- No excess noise or smoke

Maintenance

/20

- Knowledge of proper replacement parts and equipment
- Knowledge of appropriate time between maintenance



4-H STANDARD JUDGING CARD: SMALL ENGINES

Name: _____

Class: _____

Placing: First _____
 Second _____
 Third _____
 Fourth _____

Reasons (list only main points):

I place _____ at the top because:

I place _____ over _____ because:

I place _____ over _____ because:

I placed _____ on the bottom of the class because:





Image: Joseph Gilbert. <http://creativecommons.org/licenses/by-sa/2.0/>

MEETING 4

A Closer Look: Part Two

Meeting Objective: *To look deeper into a small engine and learn more about its' parts.*

Suggested Roll Calls

- Name a positive or negative quality to look for when judging a small engine.
- Name a person or business in the community that works with small engines.
- Have each member complete Meeting 3's Activity #4: Review Word Search.

Suggested Meeting Agenda (3 hrs.)

Welcome, Call to Order & Pledge		5 min
Roll Call		5 min
Club Business/Parliamentary Procedure	Reports, updates and new club business. Review Record Books and discuss any questions. Discuss the Achievement Program if not already finalized.	15 min
Topic Information Discussion	It is suggested that this meeting be done as a field trip, or a guest speaker is present. The topics of crankcase breather manufacturing, cooling systems and oil can all be discussed depending on the members' interests.	30 min
Activity Related to Reference Material	Activity #2 - Take a Breather: Crankcase Breathers (tour/demonstration)	60 min
	Activity #1 - Chill Out: Cooling Systems	15 min
	Activity #3 - To Market, to Market: A Look at Lubrication	30 min
Clean up/ Adjourn	Remind members to bring their tools, supplies and equipment needed for the next meeting.	5 min
Social Time / Snacks (Make sure a member thanks the guest speaker during this time!)		15 min

**SMALL
BUT MIGHTY
MACHINES**

TOPIC INFORMATION

Chill Out: Cooling Systems

Why do engines need cooling systems?

When fuel is burned in a combustion engine, a great deal of heat is produced. During operation, temperatures inside the cylinder wall can go higher than 200 degrees Fahrenheit or 94 degrees Celsius. The combustion chamber may approach 300 degrees Fahrenheit or 149 degrees Celsius. The remaining third of this heat is used for power, and one third escapes through the exhaust system. One third of this heat remains in the engine, and requires a cooling system to handle it. Failure to handle this excess heat can badly damage parts of the engine, and can cause it to stop functioning. The engine's efficiency is also affected by its ability to handle heat.

Which parts are included in the cooling system?

Engines are equipped with flywheels, or small vanes which serve as a fan and blow air over the cylinders. This greatly increases the cooling capacity of the engine. In a larger machine, such as a car, there is also a liquid cooling system which passes liquid over a hot engine so it can absorb it. The liquid is then passed through a heat exchanger or radiator.

What can we do to maintain this system?

Because the fins are so important to the cooling system, they must be handled carefully. Broken or damaged fins will make it more difficult to cool the engine. It is also essential that the radiator and coolant liquids be inspected and maintained regularly.

Take a Breather: Crankcase Breathers

What does a crankcase do?

- This is the part of the engine in which a vacuum is created by the movement of the piston. The air/fuel mixture is sucked in from the carburetor, through the reed valve. The crankcase is then pressurized so that the air and fuel is forced into the combustion chamber.
- In a two-stroke engine, the crankcase is located on the opposite side of the piston from the combustion chamber.
- In a four-stroke engine, the crankcase is completely separate from the combustion chamber.

What is a crankcase breather?

- This part removes harmful gases from the engine. As it's essential to have the proper mixture of air and gas.
- In some engines, there are breather caps placed on the valve covers as well to remove fumes from the crankcase.

What type of maintenance and cleaning does a crankcase require?

- In a two-stroke engine, oil must be mixed in with the gasoline. Be sure to use the right type of oil, with the right oil/gasoline ratio.
- In a four-stroke engine, the crankcase must be filled with heavy oil or there will be too much friction on the crankshaft bearings.
- The crankcase breathers should be inspected and replaced whenever necessary to ensure that the proper mixture of air and gas enters the engine. Failing to do this may result in poor performance or damage.

Lubrication

Why is lubrication needed for small engines?

- Engines have a number of moving parts, and oil is used in small engines to prevent excessive friction.
- Without oil for lubrication, an engine will overheat and parts will be damaged.

How is lubrication used in an engine?

- In a two-stroke engine, the oil and gasoline are mixed together. Be sure to use the correct type of oil, and the correct oil/gasoline ratio. This is usually one quart of oil to four gallons of gasoline. When in doubt, read the user's manual for your engine.
- Always use a fresh gasoline and oil mixture. Avoid gasoline that's been standing in the can, as it may have gummy deposits and could cause clogging in the carburetor or fuel tank. Storing fuel in metal containers helps to prevent this.
- Oils are given various viscosity indexes which tells how much its viscosity changes in different temperatures.
- Crankcase oil is classified according to service classifications.

Some Important Terminology

Service M.L. refers to gasoline engines with no severe design requirements that operate at moderate speeds or loads in warm weather.

Service M.M. refers to gasoline engines with deposit formation or excess wear when crankcase oil temperatures are high.

Service M.S. refers to gasoline engines that need special protection against wear and deposits from design characteristics, or operating conditions like start and stop driving, cold weather operation, high-speeds, heavy loads or high temp. service.

DG, DM and **DS** refer to three diesel engine service classifications. The oil chosen for an engine should correspond to one of these classifications.

What's An Additive?

An additive is an extra ingredient that is put into crankcase oil to improve its performance, and may be put into oil one at a time or in combination.

- **Antioxidants** are added to prevent varnish and sludge accumulation.
- **Corrosion preventatives** stop oil from oxidizing.
- **Detergents** are the most common additive and help to clean the surfaces inside the engine.
- **Dispersants** hold carbon and impurities in suspension.
- **Rust preventatives** may be added to reduce rust formation on polished surfaces.
- **Foam inhibitors** reduce the formation of foam in oil.
- **Viscosity index improvers** reduce the effect temperature has on viscosity changes.
- **Extreme pressure agents** ensure that there is always a film of oil on the metal.
- **Pour point depressants** help to lower the pour point of oil.

**Adapted from the BC 4-H Mechanics, Unit 1*

**SMALL
BUT MIGHTY
MACHINES**

ACTIVITIES

Activity #1: Chill Out: Cooling Systems (15 min)

Purpose and Function of Fuel Strainers - *To identify key parts of cooling system and analyze their function.*

Materials/Resources: • “Cooling Systems” Information Charts

This worksheet is intended to assist members with finding and recording important information about cooling systems. It may be given as a take-home research activity in advance, or as a set of guided notes to be filled in while demonstrations are happening. Different versions have been included for different age groups, as older members should be expected to give more detailed explanations.

Guided notes such as these not only alert members to the information they need to find and remember, but also serve as a checklist for leaders and helpers. Having this sort of worksheet on hand during demonstrations and work sessions allows leaders to check off skills that members have demonstrated, and also ensure that all important information has been covered.

1. Why are cooling systems essential to a small engine?
2. What parts of an engine belong to a cooling system?
3. How do these parts work?



Activity #2: Take a Breather: Crankcase Breathers (60 min questions and tour/demonstration)

Purpose and Function of Crankcase Breathers - *To identify key parts of a crankcase breather and analyze its function.*

Materials/Resources: • Sample crankcase breathers

This activity is intended to give members an appreciation of the manufacturing process involved in producing engine parts. It can be done as a take-home activity, but may also be the basis of a field trip. The week before you plan to examine and maintain crankcase breathers, ask members to do some research at home covering the questions listed at the bottom of the page. Allow 10-15 minutes at the beginning of your next section for members to share their findings, either in small groups or as one large group.

It is important that members gain an understanding of the materials used to produce engine parts as well as the processes involved. The crankcase is a major part of an engine, so it is a useful starting point for this investigation. However, any of the systems in an engine could be subjects for this activity.

1. Why are crankcases essential to small engines?
2. What parts of an engine connect to a crankcase?
3. What materials is a crankcase made from? Why are these materials used?



COOLING SYSTEMS: JUNIOR INFORMATION CHART

While you're learning about engine cooling systems, use this chart to write down important information. Extra space has been left so you can add your own questions.

Question	Answer
How does heat leave a working engine?	
Why is the cooling system important?	
What happens if the cooling system isn't properly maintained?	
What's the proper way to clean a cooling system?	
What happens to the cooling system if an engine is dirty?	
What are some of the dangers involved in cleaning the cooling system?	
How can you clean a cooling system safely?	
Three important parts of the cooling system are:	
What tools and supplies are used to clean the cooling system?	



COOLING SYSTEMS: SENIOR INFORMATION CHART

While you're learning about engine cooling systems, use this chart to write down important information. Extra space has been left so you can add your own question.

Question	Answer
How should you inspect a cooling system?	
Give two reasons why a cooling system is important?	
Outline the steps by which heat leaves an engine.	
Outline the steps by which heat leaves an engine.	
Which tools are used to clean a cooling system? How are they assembled?	
Describe how to safely clean a cooling system.	
How often should the cooling system be cleaned?	
When cleaning, why is it important to use a wooden scraper instead of a metal one?	



Activity #3: To Market, to Market: OIL (30 min)

Purpose and Function of Lubrication - *To identify different types of lubrication and analyze its function.*

Materials/Resources: • Sample oil and filters • Paper and pens • “To Market To Market” Worksheet
• Local auto parts retailer or print/online catalogues

Before or after you instruct members in proper methods of checking, draining and replacing oil, have them look into different types of oil and filters. If possible, ask them to visit a local auto parts retailer and investigate different types of oils and filters. Make sure to remind them that they can ask sales people questions. Have them fill out the worksheet and share their findings with other members during the next session.

This activity will not only give students an appreciation of the cost and variety of products available for engines, but will encourage them to be informed consumers and ask a variety of questions before buying. You may wish to turn this activity into a field trip, or you may wish to call a local retailer and let them know that some of your members may be visiting and asking questions.

1. Why is lubrication essential to a small engine?
2. What different products are available for engine lubrication?
3. Why are there so many different types?
4. What is the proper and safe way to check and change oil?



Activity #4: Judging Presentation Power (20 min)

To identify the key elements of a good presentation, and the develop the ability to evaluate and give constructive criticism

Materials/Resources: • Ask 5 senior members for their help before hand • Presentation Scorecard

This activity combines both public speaking and judging elements. Before hand ask 5 senior members to prepare a 2 minute presentation on their small engine project, but also direct them on how to give the presentation. Direct each senior member to represent a level from the Presentation Scorecard (Excellent, Very Good, Good, Fair and Poor). Each should create a presentation that fits within the level. Have all 5 senior members give their presentation and have the rest of the group judge their presentation. Emphasize to members that they must provide reasons for their evaluation, and their purpose in judging is to give constructive criticisms and feedback. Once all 5 presentations have been given, ask the presenting members to start a discussion with the rest of the group on who represented what level and why.

In addition to putting together an organized and effective small engines project, members must also learn to present themselves and their work in a clear and well-organized manner. Many of the activities provided throughout the project include a presentation element, but it is also useful for members to practice for actual competitions and Achievement Programs. It's also essential that they learn to provide constructive criticism, both for themselves and for other members.

PRESENTATION POWER

Presenter's Name: _____

Topic: _____

		Excellent	Very Good	Good	Fair	Poor
Introduction	- Interesting, and attention grabbing					
Subject	- Appropriate and worthwhile topic					
	- Information accurate and relevant					
	- Evidence of knowledge, adequate experience					
	- Obvious preparation					
Techniques	- Poised, friendly and enthusiastic					
	- Voice: appropriate pitch, clarity and projection					
	- Well organized and logically presented					
	- Appearance: neat and well groomed					
	- Style: speed, fluency					
	- Presence: eye contact, ability to hold audience attention					
	- Equipment / visual aids used effectively, organized presentation area					
Summary	- Effective conclusion: summarized content with impact					
	- Ability to answer questions appropriately					
	- Purpose of presentation accomplished					
Overall Score						

** Adapted from Alberta 4-H Speak and Show Score Card*



Activity #5: A Closer Look: Review Word Search (10 min)

Review key terms explained and discussed in Meetings 3 and 4.

Materials/Resources: • “A Closer Look” Review Word Search

The following word search is intended for use in reviewing key terms, concepts and skills covered by Meetings 3 and 4. You may wish to have Junior members work in groups, or find only a portion of the words.

Because members are working on engines during the meeting, time constraints may make it necessary for this activity to be done as a take-home activity.

1. What are some of the most important ideas we’ve studied in this section?

A CLOSER LOOK: REVIEW WORD SEARCH

Use the list at the bottom of the page to find key engine parts studied in this section.

D	E	F	L	E	C	T	O	R	S	L	K	N	A	T	L	E	U	G	H
Z	C	R	C	D	S	T	D	I	P	S	T	I	C	K	Q	W	N	O	C
C	A	N	C	U	F	M	U	I	T	G	S	L	E	E	H	W	Y	L	F
R	R	T	Q	O	S	E	E	N	N	B	A	F	F	L	E	S	K	D	S
E	B	N	S	R	N	E	L	T	M	T	Q	F	R	B	C	F	R	E	T
P	U	E	P	H	I	M	P	N	S	A	A	J	V	I	L	A	W	L	J
A	R	M	U	S	F	M	H	C	O	Y	J	K	Z	Q	I	O	O	M	R
R	E	I	T	C	R	A	N	K	C	A	S	E	E	R	R	B	W	E	F
C	T	D	T	Z	E	L	O	X	G	P	P	G	F	E	D	E	H	E	D
S	O	E	Y	Y	D	S	G	A	A	K	B	I	N	U	T	Y	E	D	R
D	R	S	K	C	N	C	E	L	S	I	L	I	T	I	A	U	I	D	R
O	C	G	N	K	I	R	G	J	K	T	A	S	A	E	L	S	N	Z	V
O	P	M	I	X	L	E	U	M	E	R	V	I	R	P	C	O	A	J	V
W	E	J	F	G	Y	E	A	R	T	B	U	B	L	F	E	H	O	V	Y
W	M	G	E	O	C	N	G	S	Q	J	E	L	E	M	E	N	T	C	N

Air filter
Baffles
Blower
Breather
Carburetor
Cooling System
Crankcase

Cylinder Fins
Deflectors
Dipstick
Disc
Element
Flywheels
Fuel tank

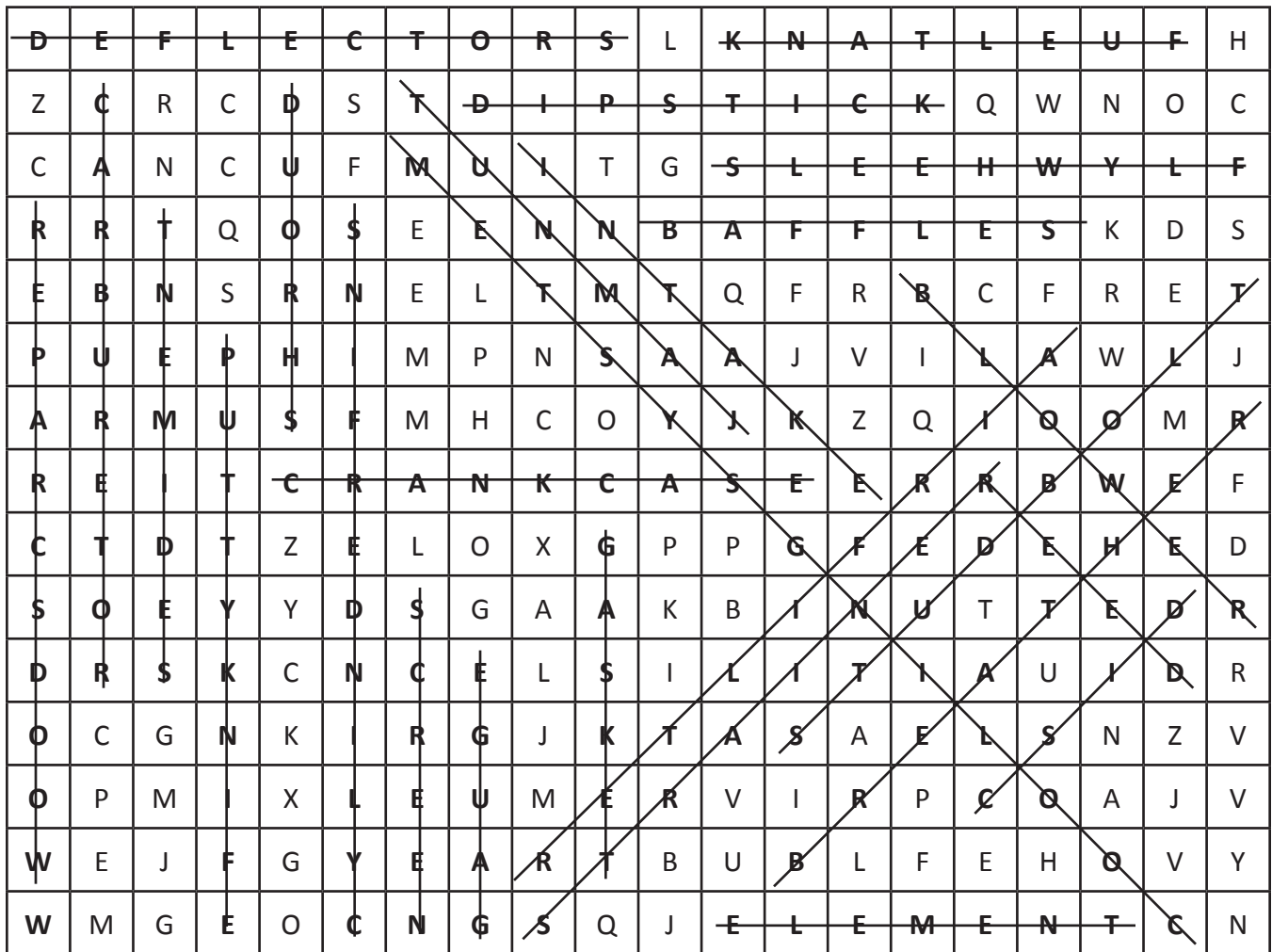
Gauge
Gasket
Intake
Jam Nut
Putty Knife
Reed
Screen

Sediment
Shroud
Strainer
Stud Bolt
Wood Scraper



A CLOSER LOOK: REVIEW WORD SEARCH (ANSWERS)

Use the list at the bottom of the page to find key engine parts studied in this section.



Air filter
Baffles
Blower
Breather
Carburetor
Cooling System
Crankcase

Cylinder Fins
Deflectors
Dipstick
Disc
Element
Flywheels
Fuel tank

Gauge
Gasket
Intake
Jam Nut
Putty Knife
Reed
Screen

Sediment
Shroud
Strainer
Stud Bolt
Wood Scraper



Image: The Adventures of Kristin Adam's photostream. <http://creativecommons.org/licenses/by-sa/2.0/>

MEETING 5

Getting It Going: Part One

Meeting Objective: *To explore and learn what makes an engine start.*

Suggested Roll Calls

- Name something you have learned new since beginning this project.
- Name a career that works with small engines.
- Name a characteristic of a good presentation.

Suggested Meeting Agenda (3 hrs.)

Welcome, Call to Order & Pledge		5 min
Roll Call		5 min
Club Business/Parliamentary Procedure	Reports, updates and new club business. Review Record Books and discuss any questions.	10 min
Topic Information Discussion	Discuss and explain spark plugs and batteries. Make sure members understand how they work, and especially how they are repaired.	20 min
Activity Related to Reference Material	Activity #1 - Spark Plugs 101	30 min
	Activity #3 - Charged Up: Batteries	30 min
	Leader/ member decided hands- on work with engines	40 min
Public Speaking Activity	Activity #4 - Two Lies and A Truth	20 min
Clean up/ Adjourn	Remind members to bring their tools, supplies and equipment needed for the next meeting.	10 min
Social Time / Snacks		10 min

TOPIC INFORMATION

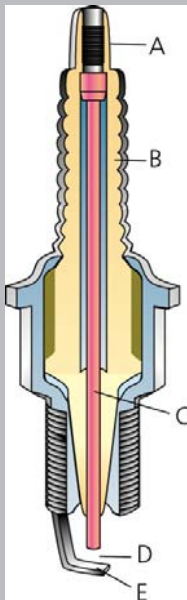
Spark Plugs 101

What does a spark plug do?

A spark plug ignites fuel in the combustion chamber by forcing electricity to arc across a gap. In order for combustion to occur there must be an extremely high voltage.

What are the parts of a spark plug?

- The connector is made of metal, and attaches to a plug wire.
- The ceramic insulator houses the centre electrode and terminal and separates them from the shell.
- The centre electrode is usually melted gas-tight into the insulator to create a specific-sized gap with the ground electrode.
- The gap is there in order to produce a spark.
- The ground electrode reaches from the threaded part of the plug and curves over to create a specific gap size with the centre electrode.



A. Connector to plug wire - Made from metal it is at the opposite end to the

B. Ceramic insulator - Houses the centre electrode and terminal and insulates from the shell.

C. Center electrode - In standard plugs it is melted gas-tight into the insulator. It protrudes slightly from the insulator creating a specific size gap with the ground electrode.

D. Gap - electricity travels across in order to produce a spark.

E. Ground electrode- In a standard plug the electrode reaches out from the threaded end of the plug and curves over to create a specific gap size with the centre electrode.

** Image from www.wikimedia.org*

What can go wrong with a spark plug?

- Spark plugs can be subject to “fouling”, which means oil and lead deposits are left by fuel and oil.
- It is also possible that the electrode gap can be too wide.
- A newer engine can usually produce 10,000-20,000 volts without a problem. Older ignition systems however, may not be able to compensate for a worn or damaged spark plug.
- Older spark plugs can reach a point where they are too worn out to be cleaned and re-gapped properly.

What happens if a spark plug is not functioning properly?

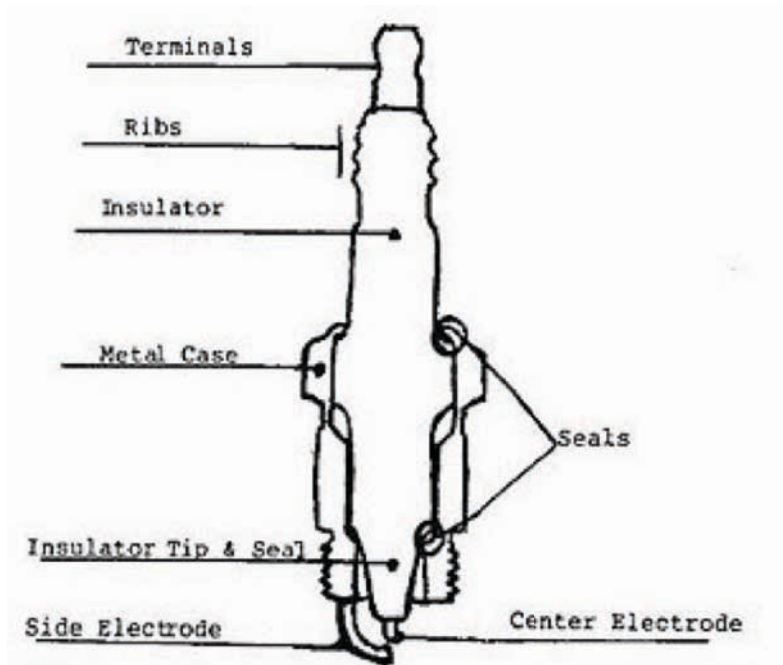
- Fuel consumption will increase.
- Crank case oil will become diluted.
- There may be excessive deposits in the combustion chamber.
- It will be hard to start the engine.
- The engine may skip.
- The engine will become less efficient.

How do I check to see if a spark plug is operating properly?

1. Disconnect the spark plug wire from the spark plug.
2. Loosen the plug in one or two turns, and remove dirt with a wood scraper or an air compressor.
3. Remove the spark plug.
4. Remove the gasket (if it's still on the cylinder head).
5. Reconnect the spark plug wire to the spark plug.
6. Ground the spark plug to the engine. Set it near (but not in) the spark plug hole.
7. Crank the engine in one or two turns.
8. Observe the spark at the electrode.
9. Disconnect the spark plug wire from the spark plug.
10. Hold the end of the spark plug wire approximately 6mm or ¼ inch from the cylinder head, or use a spark tester.
11. Crank the engine in one or two turns.
12. Observe the spark between the spark plug wire and the cylinder head.

How do I service a spark plug?

1. Spark plugs should be inspected after 100 hours of operation even if everything seems to be working.
2. Check the condition of the plug.
3. Remove oily deposits from the plug.
4. Clean threads with a wire brush.
5. Remove deposits from plugs.
6. Blow loose materials from the plug with compressed air or tap it lightly against the counter.
7. Bend the ground electrode (not the centre electrode), and leave enough room to allow for a thin (ignition point) file.
8. File the plug's electrodes until both have flat surfaces.
9. Bend the ground electrode back into its original position.
10. Determine the proper spark gap spacing for the engine.



**Image from www.wikimedia.org*

How do I install a spark plug?

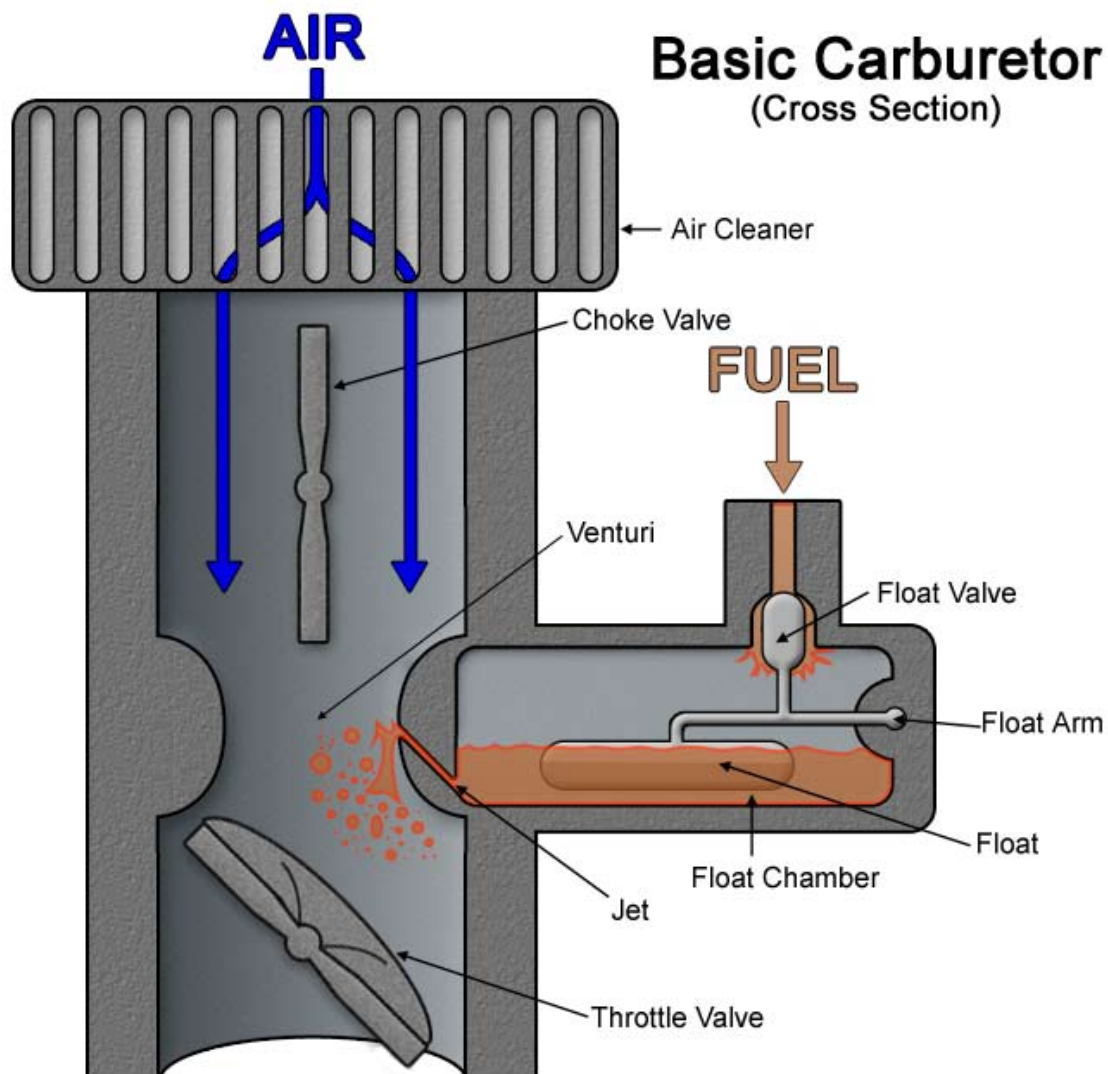
1. Replace the plug and tighten with your fingers, and put a new gasket on the plug.
2. Completely tighten the plug with a spark-plug socket wrench.
3. Check the condition of the connections and insulation on the spark plug wire when reattaching it to the spark plug.
4. Check the polarity of the spark at the spark plug on a battery ignition system. The polarity is indicated from the direction of the current.

**Adapted from Saskatchewan and Manitoba 4-H Small Engines manuals.*

Carburetors

What do carburetors do?

- A carburetor prepares fuel to be burned in combustion by mixing it with the proper amount of air. It breaks the fuel into mist that burns easily.
- It controls the air/fuel ratio, and the actual amount of air that enters the combustion chamber.



**Image from www.wikimedia.org*

What can go wrong with a carburetor?

- It can mix too much air with not enough fuel, which is called a “lean” mixture.
- It can mix too much fuel with not enough air, which is called a “rich” mixture.
- It can fail to deliver any fuel at all.

How can I make minor adjustments to the carburetor?

- There are a number of screws that may be tightened or loosened to open needle valves and correct minor problems with a carburetor. Refer to an operator's manual before making these adjustments.
- These valves are the high speed valve, idling valve or the idle speed stop screw.

How can I check to see if the carburetor is working properly?

1. Start the engine to see if it will start easily if the spark is strong, and if fuel is entering the cylinder.
2. Perform the "wet thumb test". Remove the finger and place your thumb over the spark plug hole. Close the choke valve and crank the engine with the starter 3 or 4 times. Remove your finger and check for moisture. If wet, the fuel is being delivered to the cylinder by the carburetor.
3. Perform the "priming test". Using a plastic straw/ small length of tubing, put 5 ml of gas into the combustion chamber. Reinstall the spark plug and start the engine. If the engine runs for only a short time - not enough fuel is getting past the carburetor. If the engine does not start, the problem is not the carburetor.
4. Perform the throttle test by operating the engine at idling speed for warm up. Advance the throttle suddenly. If the engine does not accelerate smoothly and evenly, then the fuel mixture is too lean.
5. Perform the exhaust test by checking the exhaust smoke. The fuel mixture is too rich if the engine gives off black smoke, burns too much fuel or idles roughly.

What should I do when making adjustments to the carburetor?

1. Fill the fuel tank with clean, fresh gasoline.
2. Check the throttle and linkage for mechanical condition and freedom of action.
3. Service the engine before the carburetor.
4. Check for air leaks in the carburetor manifold.
5. Check the ignition and Locate the idle-speed stop screw.
6. Locate and identify the fuel-air mixture adjusting screws.
7. Make initial carburetor adjustments and adjust the idle-speed stop screw.

**Adapted from Saskatchewan 4-H Small Engines manual.*

Charged Up: Batteries

What do batteries do in a small engine?

- Small engines normally have a magneto ignition system which is self-contained, and distributes electricity to ignite the combustible mixture in the combustion chamber. A magneto system also makes low voltage into high tension voltage, and distributes it to cylinders at the right moment.
- However some stationery engines, as well as the ones on tractors, require a battery to allow ignition.

What are the parts of a battery system?

- Battery ignition systems consist of a battery, an ignition coil, a distributor, a condenser, an ignition switch, spark plugs, as well as low and high tension wiring.
- A lead-acid storage battery is used to supply power, and also to provide electrical energy for the ignition system. It isn't made to store electricity, but converts chemical energy into electrical energy. The amount of power generated depends on the amount of chemicals used in the battery.
- The ignition coil transforms or steps up the 6-12 volts provided by the battery to a high tension voltage of about 20,000 volts. It takes this many volts to jump the spark plug gap in the combustion chamber.
- The ignition distributor opens and closes the primary ignition circuit, and distributes the high tension current to various cylinders in the engine. It also controls the point at which the breakers open, which allows or slows the spark.
- The ignition condenser prolongs the life of breaker points by reducing arcing.
- The spark plug provides the gap in the combustion chamber across which the electrical spark must jump in order to achieve combustion.
- The ignition switch connects and disconnects the ignition system from the battery to allow the engine to be started or stopped.

How do I test a battery?

- Most batteries only last between 3-5 years. When replacing your battery, make sure the new one is exactly the same model as the original.
- While changing a battery, make sure you remove jewellery, as metal is an excellent conductor for electricity. You should also wear protective clothing, gloves and safety goggles, as chemicals from the battery will burn your skin and eyes.
- Devices are available to test batteries. Be sure to attach the correct side of the metre to the correct side of the battery. Most devices are colour coded with black (negative) and red (positive).

**Adapted from Saskatchewan 4-H Small Engines manual and http://www.2carpros.com/how_to/battery.htm*

ACTIVITIES

Activity #1: Spark Plugs 101 (30 min)

Purpose and Function of Spark Plugs - *To identify key parts of a spark plug and analyze its function.*

Materials/Resources: • Sample spark plugs • “Spark Plugs 101” Worksheets

Instruct members on the proper way to remove, check and replace sparkplugs, and have them complete this worksheet. It will encourage a better understanding of how spark plugs actually work. A worksheet for both age groups has been provided, and these may be done as a take-home activity in the previous week. Be sure to leave time during a session to share their findings.

Many engine parts have their own fascinating history and construction. Allowing members time to learn about these features will give them an even broader understanding of physics and mechanics in general.

1. Why are spark plugs essential to a small engine?
2. How do these parts work?
3. What other machines and devices use spark plugs?
4. How and when were spark plugs invented?

Activity #2: Defining Carburetors (30 min)

Purpose and Function of Carburetors - *To identify key parts of a carburetor and analyze its function.*

Materials/Resources: • Sample carburetors/diagram • Pencil and paper
• Reference guides • Internet access (optional)

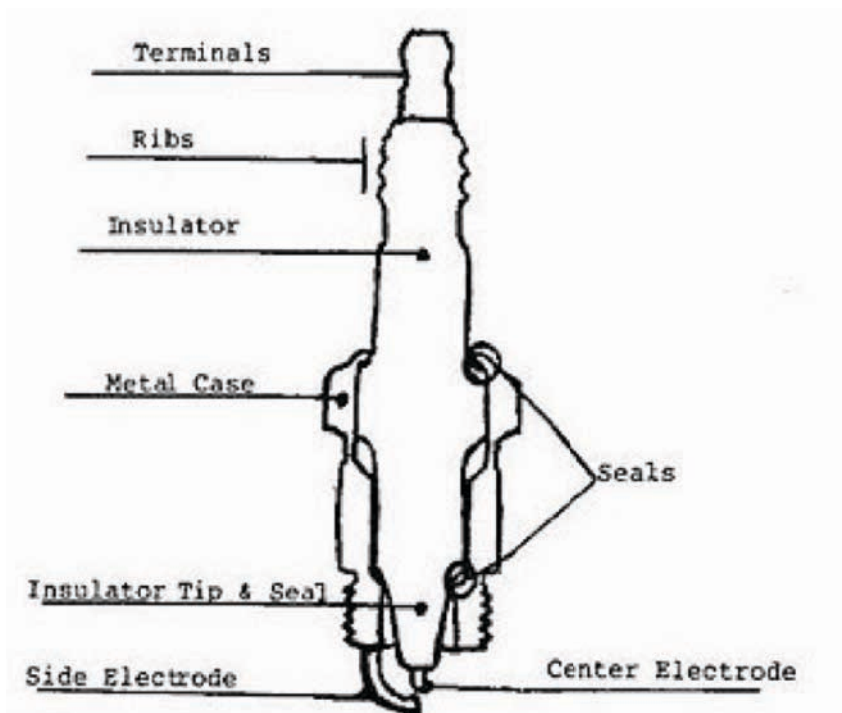
This activity may be given as a take-home exercise, or members may complete it as they explore carburetors during a session. Have members draw a diagram of a basic carburetor, and label it using information found on the internet, reference books, or from experts in the field. Have them note any definitions or additional information on the diagram.

This diagram will act as a great reference for members. For many visual learners actually drawing the parts helps them retain the information; making it easier for them to identify the parts when working on an actual small engine.

1. Why are carburetors essential to a small engine?
2. What parts of an engine connect to a carburetor?
3. How do these parts work?

SPARK PLUGS 101: SENIOR WORKSHEET

Using the internet or books from your local library and the diagram provided here, explain what each part of a spark plug does.



**Image from www.wikimedia.org*



Activity #3: Charged Up: Batteries (30 min)

Purpose and Function of Batteries - To identify key parts of a battery and analyze its function.

Materials/Resources: • Sample batteries • “Charged Up: Batteries” Worksheet
• Internet access (optional)

Have members complete the worksheet as they learn to charge and replace batteries during a session. This activity may also be given as a take-home exercise after the demonstration. Have members fill in the blanks using the internet, reference books, or information given by an expert.

This worksheet may be used as a reference for guided notes, or as a separate activity. Giving members important terms in advance often makes it easier for them to identify and record important information.

1. How do batteries work in a small engine?
2. How is an engine battery safely tested and replaced?
3. What type of battery is appropriate for each type of engine?



Activity #4: Two Lies and A Truth (20 min)

To develop listening, reasoning and public speaking skills

Have each member make three statements about him/herself and a small engine, two of them lies and the third true. For example, “My mom drives a blue car with a 4 cylinder engine. My father owns a green lawn mower. My grandmother drives a small motor scooter every day.” Or “I want a snowmobile. I hate driving the lawn tractor. My hands always shake after using a Whipper-Snipper.” The audience now has to decide which statement is the true one. Make it clear that these statements should be facts not subjective statements.

This activity not only lets members be creative, but also allows them to learn about one another. This can be a very fun and interesting way to approach the subject of speaking to a group. This activity is more casual and should be less nerve-racking for even a shy public speaker.

** Adapted from Alberta 4-H's Speak Pack.*

CHARGED UP: BATTERIES

After you've had a chance to study engine batteries in your group sessions and on your own, try these true or false questions to quiz yourself on your knowledge. If the statement is false, try to write in the correct answer.

True or False?

1. Engine batteries are usually rechargeable.
2. Engine batteries contain acid that assists in a chemical reaction involved in producing electricity.
3. An engine battery never needs to be replaced. It can be recharged over and over without ever wearing out.
4. A starting or shallow cycle battery is intended to run for long periods of time, while a deep cycle is intended for short bursts of energy.
5. The acid in a battery needs to be replaced on a regular basis.
6. In many areas of Canada and the United States, certain parts of batteries can be recycled.
7. Many batteries are printed with dates, so users can tell how old they are, and whether they need to be replaced.
8. The white powder that appears when a battery corrodes is not harmful to humans.
9. Faulty engine batteries can sometimes bulge and even explode.
10. When replacing or handling batteries, it is important to wear safety gear like goggles, overalls and gloves.



CHARGED UP: BATTERIES (ANSWERS)

After you've had a chance to study engine batteries in your group sessions and on your own, try these true or false questions to quiz yourself on your knowledge. If the statement is false, try to write in the correct answer.

True or False?

- 1. TRUE** Engine batteries are usually rechargeable.
- 2. TRUE** Engine batteries contain acid that assists in a chemical reaction involved in producing electricity.
- 3. FALSE**
An engine battery never needs to be replaced. It can be recharged over and over without ever wearing out.
- 4. FALSE** A starting or shallow cycle battery is intended to run for long periods of time, while a deep cycle is intended for short bursts of energy.
- 5. FALSE** The acid in a battery needs to be replaced on a regular basis.
- 6. TRUE** In many areas of Canada and the United States, certain parts of batteries can be recycled.
- 7. TRUE** Many batteries are printed with dates, so users can tell how old they are, and whether they need to be replaced.
- 8. FALSE** The white powder that appears when a batter corrodes is not harmful to humans.
- 9. TRUE** Faulty engine batteries can sometimes bulge and even explode.
- 10. TRUE** When replacing or handling batteries, it is important to wear safety gear like goggles, overalls and gloves.



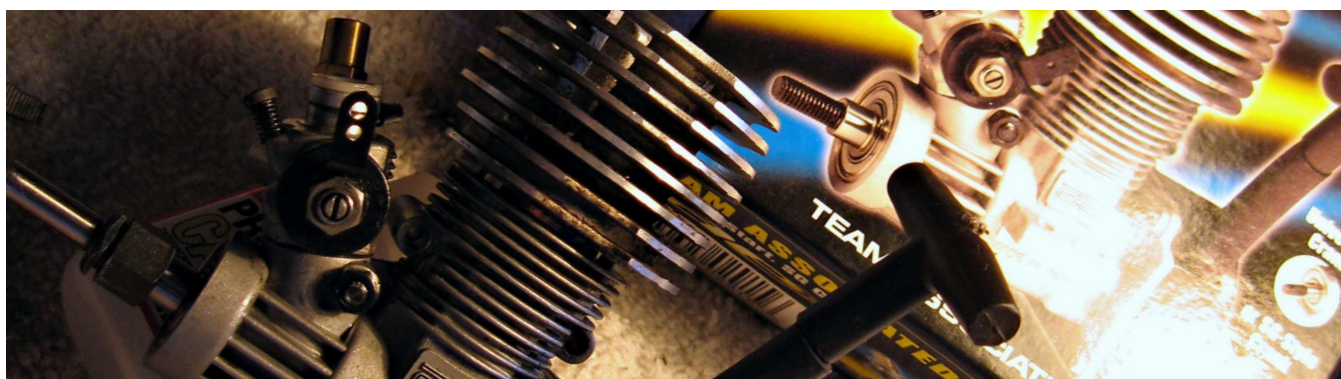


Image by Scott Pargett _<http://creativecommons.org/licenses/by/2.0/>

MEETING 6

Getting It Going: Part Two

Meeting Objective: *Focus on safety and proper procedures while starting up and shutting down a small engine*

Suggested Roll Calls

- Name a challenge you have encountered while working on your small engine.
- Name a success you have accomplished while working on your small engine.
- Do you prefer working with a two-stroke or four-stroke engine, and why?

Suggested Meeting Agenda (2.5 hrs.)

Welcome, Call to Order & Pledge		5 min
Roll Call		5 min
Club Business/Parliamentary Procedure	Reports, updates and new club business. Review Record Books and discuss any questions.	10 min
Topic Information Discussion	Review the proper procedure for starting up and shutting down an engine. Discuss any other topics members wish to cover before the club completes.	15 min
Activity Related to Reference Material	Activity #2 - Starting Up and Shutting Down	30 min
	Leader/ member decided hands- on work with engines	45 min
	Activity # 3 - Judging a Small Engines Project	20 min
Clean up/ Adjourn	Encourage members to fill out the “What I’ve Learned Checklist” and “Project Evaluation” found in their Record Books.	10 min
Social Time / Snacks		10 min

TOPIC INFORMATION

We Didn't Start a Fire: Fuel and Safety

General Tips for Fuel Safety

- Fuel should never be handled in the presence of flame or spark.
- Smoking around fuel is strictly prohibited.
- Fuel can burn skin if left on for long periods of time, and should be washed off immediately with soap and water. All efforts should be made to keep fuel away from eyes as it can damage membranes.
- Fumes from fuel should never be inhaled, as they may burn and damage lung tissue. Always use fuel in a well-ventilated area.
- Clothing soaked with fuel should be changed and washed immediately, as it may come in contact with skin and will become flammable.
- Before refilling engine fuel make sure that the engine is turned off and cool.
- Pour the fuel in slowly to avoid spilling and splashing.
- Store fuel in an approved container, in a safe area and at the appropriate temperature. When in doubt check instructions from the manufacturer.
- Prepare for emergencies by keeping a fire extinguisher, an eye wash station, and a fire blanket handy.

**Adapted from www.ccohs.ca.*

How do I start an engine?

As with all work on engines make sure your work area is safe, that you're working with the proper materials and equipment, and that you're wearing appropriate clothing and safety equipment. Make sure you have enough room to start your engine, and that there aren't any other people in the way.

1. Open the fuel shut-off valve (if your engine has one) all the way to prevent leakage around the valve stem.
2. Close the choke valve or prime the carburetor. This will make more fuel available. If your engine has a fuel pump and a choke but no primer, crank it a few times with the ignition switch off. Remember that there are a variety of choke-control designs. When in doubt - check your user's manual.
3. Set the throttle at the position recommended for your engine. Usually one quarter to half way open is sufficient. If your choke and throttle lever are combined, move the lever to the choke position for starting. When the engine starts, move it to the run position. This isn't necessary if your engine has an automatic choke.
4. Turn on the ignition switch (if your engine has one). These are usually marked on/off.
5. Crank the engine. Remember that rope-wind, rope-rewind, wind-up and electrical starters have different procedures for doing this. Consult your manual for specific instructions.
6. Open the choke valve part or all of the way when the engine starts. Some valves will automatically open completely, and others open only partially until the engine warms up.
7. Adjust the throttle for warm-up and set it for fast idle. You should never open the throttle completely, gun the engine, or apply a load until the engine has been allowed to warm up for at least one minute. Stay clear of moving parts while the engine is running.
8. If the engine doesn't start, repeat the first four steps.

How do I shut down an engine?

1. Remove the load from the engine. Failing to do this will "shock" an engine and will stall it. This can cause unnecessary wear to the bearings.
2. Reduce the engine speed to idle, allowing the engine to cool for one or two minutes at 1/3 throttle speed. Stopping the engine at a high temperature causes wear on its parts.
3. Turn off the ignition switch. If you are using a battery engine be sure to leave the ignition switch at "off", or the battery will discharge. If your engine is controlled by an ignition key be sure to remove it so that children and other users will not hurt themselves. If the engine has no key, remove the spark plug wire from the spark plug.
4. Close the fuel tank shutoff valve (if the engine has one). This takes the pressure off the carburetor diaphragms and/or float, and prevents fuel leaks.
5. Store the engine in a dry, protected area. If you won't be using the engine for 30 days or more, drain the fuel tank and carburetor to prevent gum from forming in the fuel system.
6. Fresh gasoline and oil should be used when you use it again.

ACTIVITIES

Activity #1: We Didn't Start a Fire: Fuel and Safety (20 min)

Safe Use and Handling of Engine Fuel - *Identify potential hazards of engine fuel and strategies for avoiding them.*

Materials/Resources: • Safety posters, books and brochures
• “We Didn't Start a Fire” Worksheet

Discuss the risks of working with fuel, and the correct use and handling of engine fuel. Pass out the worksheet and have the members fill in the blanks using the word list at the bottom of the page. Be sure to leave a few minutes for questions and concerns. To make the activity more challenging for more experienced members leave off the word list. This activity may be given as take-home activity.

This activity relates closely to much of the information in Meeting 1 concerning safety, and may be used as a quick review while learning about engine systems and processes.

1. Why are fuels dangerous?
2. What can happen if fuel is used or stored improperly?
3. How can you ensure that fuel is used safely?

Activity #2: Starting Up and Shutting Down (30 min)

Proper Methods for Starting Up and Shutting Down Small Engines - *Demonstrate knowledge and skills concerning proper methods for start up and shut down of small engines.*

Materials/Resources: • “Engine Start-Up and Shutdown” Checklist

Use the checklist provided while running through procedures to ensure that members are familiar with all the steps involved in start up and shut down.

Additional steps and skills may be added to the checklist, and they may be modified to suit various age levels.

1. What are the proper steps involved in starting and shutting down a small engine?
2. What steps must be taken to ensure that safety hazards are minimized?
3. What equipment and supplies are necessary for these processes?

WE DIDN'T START A FIRE: FUEL SAFETY

Using the word list given below, fill in the blanks. You may not use the same word twice.

1. No one should ever _____ or use _____ when around fuel because it is extremely flammable, even if there are only fumes.
2. Fuel will _____ skin if it comes into contact with it. If this happens, be sure to wash immediately with soap and water.
3. Fumes from fuel can harm lungs, so you should always avoid _____ them in, and always use fuel in a _____ area.
4. Before fueling an engine, always turn off the _____.
5. Refill an engine slowly to avoid _____ the fuel.
6. You should have a _____ close by, just in case of an emergency.
7. If you spill any fuel on your _____, be sure to take them off and wash them before using them again.
8. Always store fuel in a proper _____.
9. There are different types of fuel. Make sure you use the one that's right with your _____.
10. When in doubt, ask for help, or read the _____.

Spilling	Container	Breathing	Safety Instructions
Ventilated	Engine	Smoke	Clothes
Burn	Fire Extinguisher	Ignition	Flame

**Adapted from www.ccohs.ca.*



WE DIDN'T START A FIRE: FUEL SAFETY (ANSWERS)

1. No one should ever **smoke** or use **flame** when around fuel because it is extremely flammable, even if there are only fumes.
2. Fuel will **burn** skin if it comes into contact with it. If this happens, be sure to wash immediately with soap and water.
3. Fumes from fuel can harm lungs, so you should always avoid **breathing** them in, and always use fuel in a **ventilated** area.
4. Before fueling an engine, always turn off the **ignition**.
5. Refill an engine slowly to avoid **spilling** the fuel.
6. You should have a **fire extinguisher** close by, just in case of an emergency.
7. If you spill any fuel on your **clothes**, be sure to take them off and wash them before using them again.
8. Always store fuel in a proper **container**.
9. There are different types of fuel. Make sure you use the one that's right with your **engine**.
10. When in doubt, ask for help, or read the **safety instructions**.

**Adapted from www.ccohs.ca.*

ENGINE START-UP AND SHUTDOWN CHECKLIST

Use this checklist to help keep track of the important parts of the start-up/shutdown process. Once you have practiced, have your leader observe and initial each step.

Task	Leader's Initials/ Date
1. a) Open the fuel shut-off valve	
b) Identify the parts	
2. a) Close the Choke.	
b) Identify the parts.	
c) Make sure ignition switch is turned off	
d) Crank the starter	
3. a) Set the throttle	
b) Identify the parts	
c) Set it at a recommended position	
5. a) Crank the engine.	
b) If using a rope wind starter type, wind rope around fly wheel	
c) Crank slowly to a compression stroke	
d) Rewind the rope	
6. a) If using a rope rewind starter type, crank the engine to a compression stroke.	
b) Slacken the rope	
c) Allow the rope to rewind	
d) Pull the rope briskly and firmly	
e) Do not pull the rope too far.	
f) Allow the rope to rewind while holding the handle	

Chart continues on next page...



Task	Leader's Initials/ Date
7. a) If using the windup starter type, place the release lever into windup position.	
b) Lift the handle to the cranking position	
c) Extend the handle to the cranking position	
d) Wind the starter	
e) Fold the windup handle to the retracted position	
f) Move the release lever to the "run" position	
8. a) If using the electric starter type, locate the switch	
b) Engage the switch	
c) Practice holding this for 10 seconds, 15 seconds and longer	
d) Allow the switch to return to the off position	
9. a) Stop the engine	
b) Reduce the idle speed	
c) Stop without a load.	
d) Use the correct throttle speed	
e) Time it to 1 and/or 2 minutes	
f) Turn of the ignition	
g) Close the fuel tank and shut-off valve	

**Checklist adapted from the Saskatchewan 4-H Small Engines Member's Guide.*



Activity #3: Judging a Small Engines Project (20 min)

Judging small engine projects - *Develop analytic and communication skills*

Materials/Resources: • “Small Engines Judging” Sheet (Meeting 3)

Now that members have a working engine to show, have them arrange their work in display form and allow a portion of a session for them to judge each other’s work. Split the members into groups, and the engines into classes. Have each group judge one class. Emphasize the importance of giving reasons for their decisions, so that others may use the reasons as a means to improve their work and their skills. Give members a time limit, and explain the importance of prioritization and time management. Use the judging sheet provided, or use a sheet created in an earlier activity by leaders and members.

Whether they are involved in a competition or just evaluating the work of others within their 4-H group, members need to learn to rank and critique projects constructively. Judging activities not only encourage them to organize and present their work clearly and effectively, but also strengthens their critical thinking skills. Judging gives members the opportunity to be an expert on the topic of small engines, as long as they can back up their opinions and evaluations with strong, well thought out reasons.

1. Are the comments/reasons I’ve given, constructive and helpful to fellow members?