Name_____

Internal Combustion – Sample Activity

Purpose

All engines operate in a sequence of events: intake, compression, ignition, power, and exhaust. Technicians should understand how engines work before making repairs. How does the orientation of engine components change during each event? What are the chemical inputs and outputs of each event?

An engine converts the chemical potential energy found in fuel into mechanical energy. The major inputs of a four-cycle internal combustion engine are the gasoline and oxygen mixed to make a combustible charge. Once the spark plug ignites the combustible charge, the engine does work, loses energy in the form of heat, and releases exhaust in the form of carbon dioxide and water. Work, heat, and exhaust are all examples of outputs of an engine.

The energy from the explosive charge is transferred throughout the engine by the piston, connecting rod, and crankshaft. The piston moves up and down from top dead center (TDC), position closest to the spark plug to bottom dead center (BDC), position furthest from the spark plug. In addition, valves open and close to allow fuel into and release exhaust from the engine. These machine components have specific orientations during each engine event.

How can engine events, inputs, and outputs be communicated in a storyboard?

Materials

Per pair of students:

- *Sample Engine Event Cards*
- Glue stick, paste
- Posterboard

Per student:

- Pencil
- *Agriscience Notebook*
- Scissors
- *Small Gas Engines* text

Per class:

- Small engine, cutaway

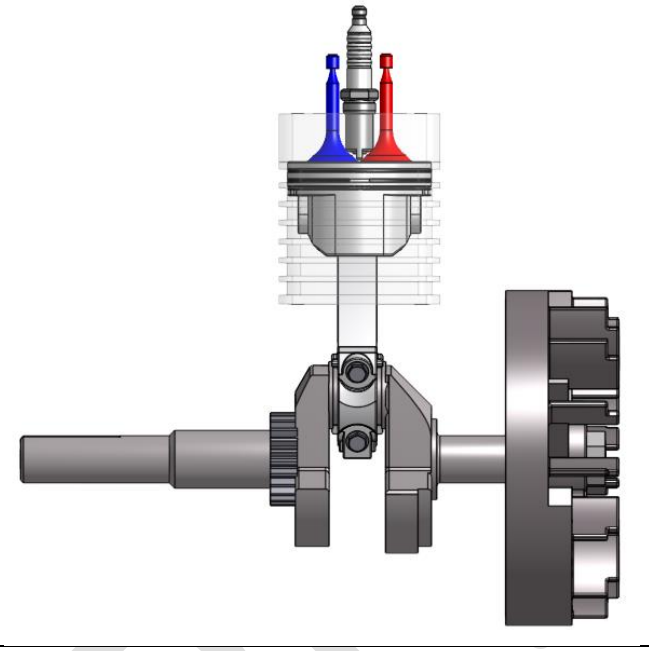
Procedure

Complete a table organizing the actions of engine components during each event of the four-stroke process. Then construct a storyboard explaining the inputs, outputs, and events in a four-cycle engine.

Part One – Small Engine Inputs and Outputs

1. Refer to the image of a small gas engine's internal components in Table 1. Use the *Small Gas Engines* text for reference.

Table 1. ***4-Stroke Theory and Operation***

Items to Label	Image
Connecting rod Crankshaft Cylinder Exhaust valve Flywheel Intake valve Piston Spark plug	

2. Record the purpose of each component listed in Table 2. Then, draw a picture of each component. Refer to the textbook to guide your research.

- Connecting rod
- Crankshaft
- Cylinder
- Exhaust valve
- Flywheel
- Intake valve
- Piston
- Spark plug

Table 2. ***Engine Components***

Component	Purpose	Picture
Connecting rod		
Crankshaft		
Cylinder		
Exhaust valve		
Flywheel		
Intake valve		
Piston		
Spark plug		

3. Record the inputs and outputs of chemical combustion in Table 3.

Table 3. *Combustion Inputs and Outputs*

Component	Inputs	Outputs
Engine, 4-cycle		

Part Two – Four Cycle Theory

Your teacher will present the **4-Cylce Theory and Operation** (https://www.thepowerportal.com/nA/English/PowerChannel/Foundations/FourCycleTheory.htm) video from the Power Portal. Record notes below.

4-Cylcle Theory and Operation Notes

Part Three – Storyboard

Work with a partner to create a storyboard of the small engine events. During the events, detail the chemical inputs and outputs.

Engine Events

1. Obtain a posterboard and copy of *Activity 2.1.1 Engine Event Cards* from your teacher.
2. Use scissors to cut out the *Event Headings* and *Event Image*s from the event cards. Save the *Event Details* and *Event Captions* for later use.
3. Place the cut cards evenly on your posterboard. Use the guidelines below to match the event images and titles. Use your notes in Table 2 as guidance.
    - Place the *Event Headings* in order of sequence across the top of the posterboard.
    - Place the corresponding *Event Images* under each heading. Place the piston on top of the engine cylinder to communicate the correct position and directional movement.
    - Use your notes and your teacher's cutaway engine as reference tools when needed.
4. Ask your instructor for feedback on the position of images and headings. Continue to Step 5 when directed by your teacher.
5. Paste the cards in place with a glue stick.

Event Details

6. Use scissors to cut out the *Event Details* and *Event Captions* from the event cards.
7. Place the cut cards on your posterboard. Use the images to add detail to describe each event, including inputs and outputs.
8. Read the captions. Add the captions below each event. There should be three captions per event.
9. Ask your instructor for feedback on the position of event details and captions. Continue to Step 10 when directed by your teacher.
10. Paste the cards in place with a glue stick.

Sample Teacher Notes

Students work in pairs to list the inputs and outputs for each four-stroke cycle event in a small engine. Then they develop a storyboard describing the five events in a four-stroke cycle engine.

Teacher Preparation

1. Print *Sample Engine Event Cards* for each pair of students. Print the document single-sided and in color.
2. Play the *4-Cylce Theory and Operation* video from the *Power Portal* during Part Two. Engage students with the follow-up discussion questions listed in *Video Discussion*.
3. Observe student storyboards during Part Three. Students call on the teacher during the two periods bulleted below. During each time, use Socratic questioning to guide student thinking and help them correctly place the components of their storyboard.
    - Headings and event images – Do they match? Are they in the correct order?
    - Event details and captions – Do the captions match the image?
4. Purchase or construct a cutaway engine, such as shown in Figure 1 (A cutaway engine basic engine component, with portions cutaway from the engine to increase student views). Students use the cutaway engine to inquire about the position and function of engine components during Part Three. Use the **Cutaway Instruction Guide** on the Power Portal for building a cutaway engine. Similarly, such engines can be purchased from **EETC**.

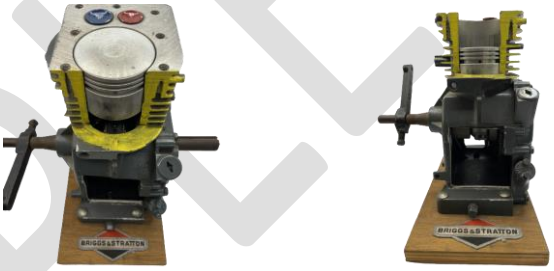


Figure 1. Cutaway Engine Example

Student Performance

Part One

Students begin the activity by defining the main components of a four-stroke cycle engine. They match parts names to a diagram and list the functions of each component. Students also draw a picture of each component. Lastly, students use their text to outline the inputs and outputs of the internal combustion engine.

Part Two

Present the *4-Cylce Theory and Operation* video from the *Power Portal*. Students take notes in their student worksheets. Follow up the video with discussion questions listed in *Video Discussion*.

Part Three

Part Three is true teacher-guided inquiry. Students use their foundational knowledge from Part One, notes from Part Two, and observations from a cutaway engine to construct a storyboard of the engine events. First, students cut the *Activity 2.1.1 Engine Event Cards*. They place the cards in a specific order and sequence to describe each engine event. Students use provided questions to describe each event and add detail with colored pencils. Refer to Table 3 for reference when guiding student inquiry with questioning.

Results and Evaluation

During this activity, students use resources to identify key engine components and their functions during engine events. Figure 2 and Tables 1–2 provide sample responses for Part One. Confirm student understanding before moving on to Part Three. Use Figure 2, Tables 4–5 and the *4-Cylce Theory and Operation* discussion questions to access student knowledge.

Table 6 is the key for Part Three. Refer to this table to guide student inquiry with Socratic questioning during Part Three. *Activity 2.1.1 Internal Combustion* is an activity, not a project – at the end, student results should mirror the examples.

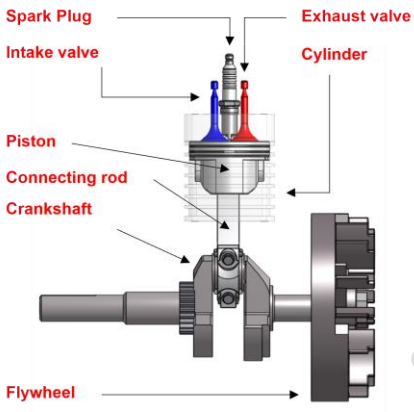


Figure 2. 4-Stroke Components

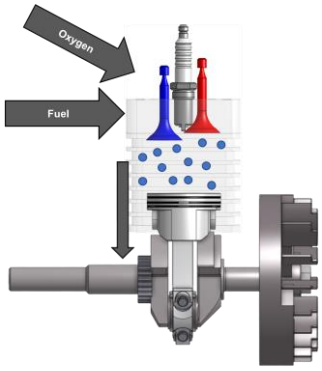
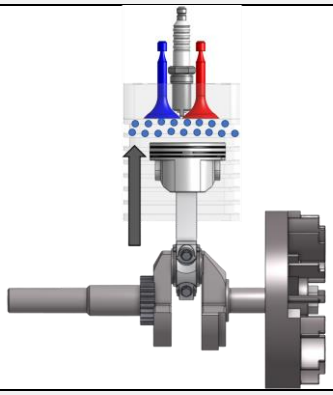
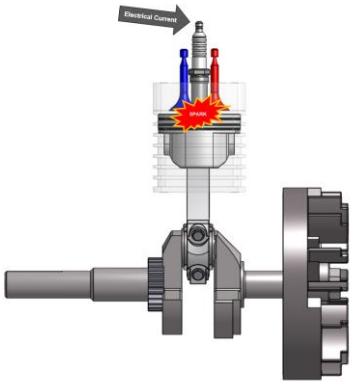
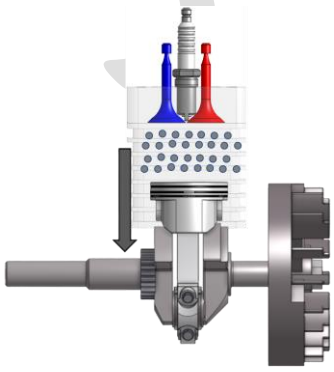
Table 4. *Engine Components*

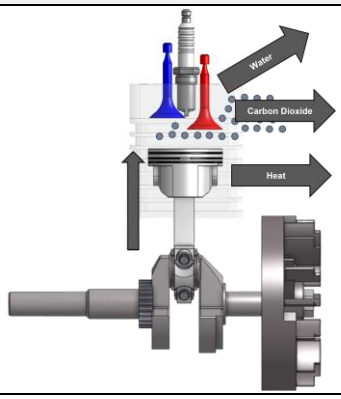
Component	Purpose
Connecting rod	**An engine component that transfers motion from the piston to the crankshaft and functions as a lever arm.**
Crankshaft	**An engine component includes the cam gear, cam lobes, and bearing surfaces. The crankshaft moves and applies energy from the piston to the PTO.**
Cylinder	**Fuel combustion occurs in the cylinder, creating force and power. The cylinder ensures compression for combustion and thrust.**
Exhaust valve	**An engine operation event in which spent gases are removed from a combustion chamber and released into the atmosphere.**
Flywheel	**Provides energy for the compression stroke.**
Intake valve	**An engine component that opens and closes at precise times to allow the flow of an air-fuel mixture into a cylinder.**
Piston	**A cylindrical engine component that slides back and forth in a cylinder bore by forces produced during a combustion process.**
Spark plug	**A component that isolates electricity induced in secondary windings and directs a high voltage charge to the spark gap at the tip of a spark plug.**

Table 5. *Combustion Inputs and Outputs*

Inputs	Outputs
Fuel **Oxygen**	**Heat** **Water** **Carbon Dioxide**

Table 6. ***Example Storyboard***

Intake Event	
	**The intake valve opens up, pulling a mixture of air and fuel from the carburetor.**
	The piston moves from Top Dead Center (TDC) to Bottom Dead Center (BDC), creating a lower pressure area.
	The low-pressure area creates a vacuum, pulling in a mixture of air and fuel from the carburetor.
Compression Event	
	**The intake and exhaust valves are closed.**
	The piston moves from Bottom Dead Center (BDC) to Top Dead Center (TDC), compressing the air-fuel mixture inside the engine cylinder.
	Compressive forces vaporize fuel molecules to smaller particle sizes, increasing combustibility.
Ignition Event	
	**The intake and exhaust valves are closed.**
	As the piston approaches Top Dead Center (TDC), the flywheel moves past the magneto and armature, creating an electromagnet charge.
	The spark plug sparks in the cylinder, combusting the vaporized fuel.
Power Event	
	**The intake and exhaust valves are closed.**
	Pressure propels the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).
	The combustion creates pressure in the cylinder. Products include water vapor and carbon dioxide.

Exhaust Event	
	**The exhaust valve opens.**
	The piston moves from Bottom Dead Center (BDC) to Top Dead Center (TDC), pushing the byproducts of combustion through the muffler.
	Engine exhaust is a mixture of water vapor, carbon dioxide, and heat.

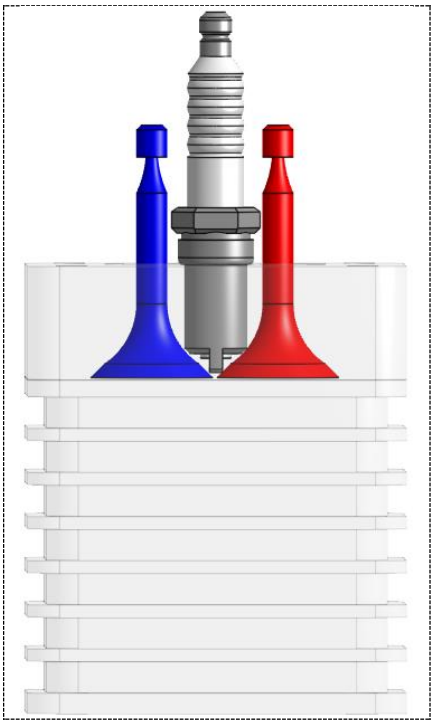
Sample Activity

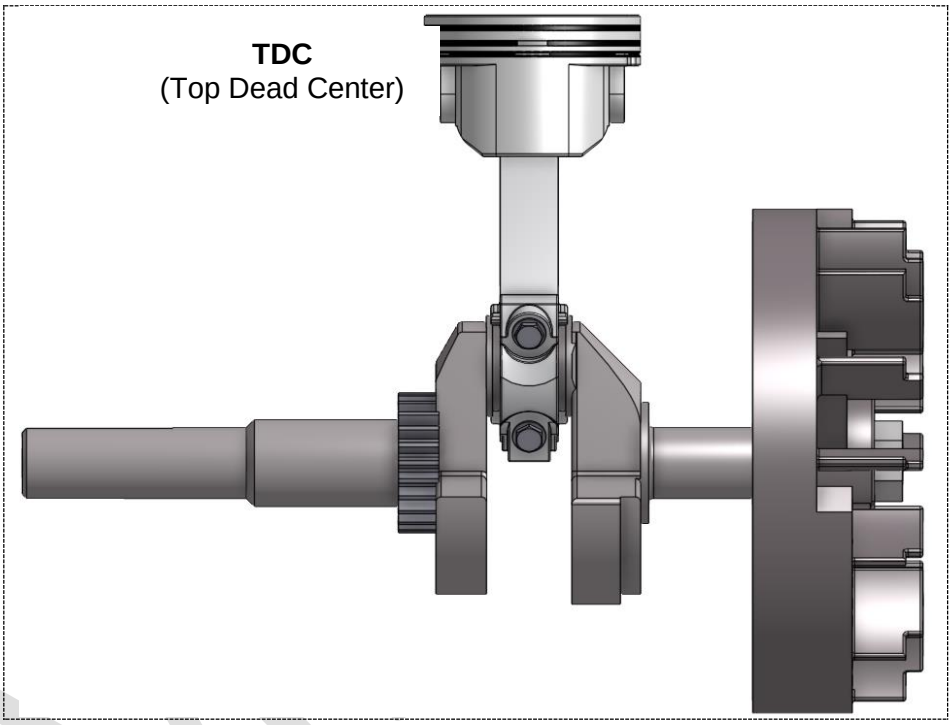
This sample is a modified version of *Activity 2.1.1 Internal Combustion* from the CASE 4 Learning *Small Gas Engines* (SGE) curriculum. For more information about the course visit **www.case4learning.org**. The sample has been modified for time and material simplification to fit a workshop format and is not for resale or profit. Teachers are permitted to use this sample in their classroom without certification.

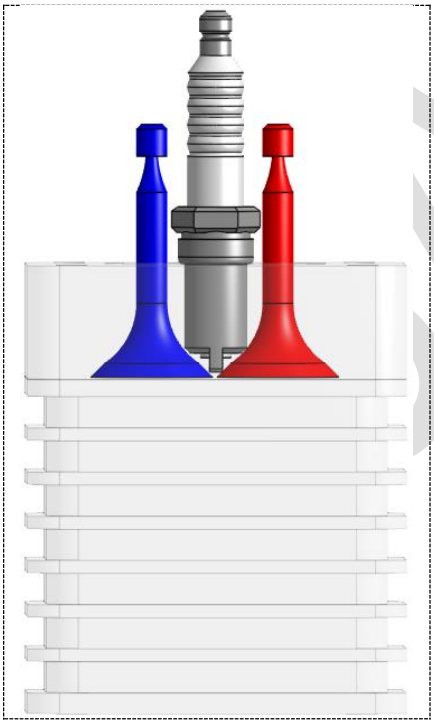
Contact **CASE 4 Learning** to receive permission to use this sample at a teacher professional development.

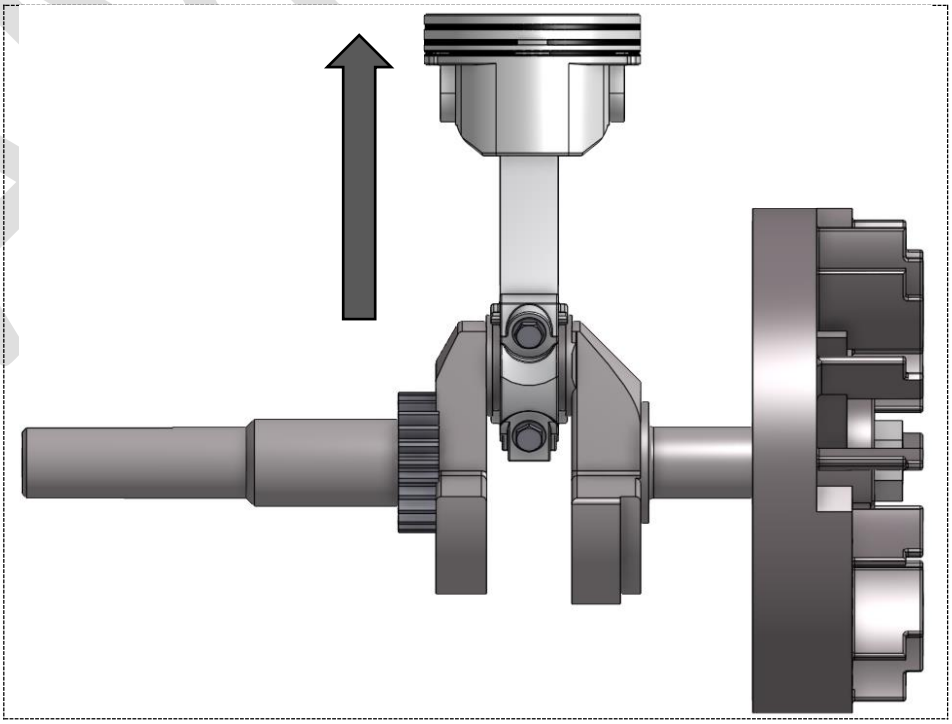
Sample Engine Event Cards

Event Images

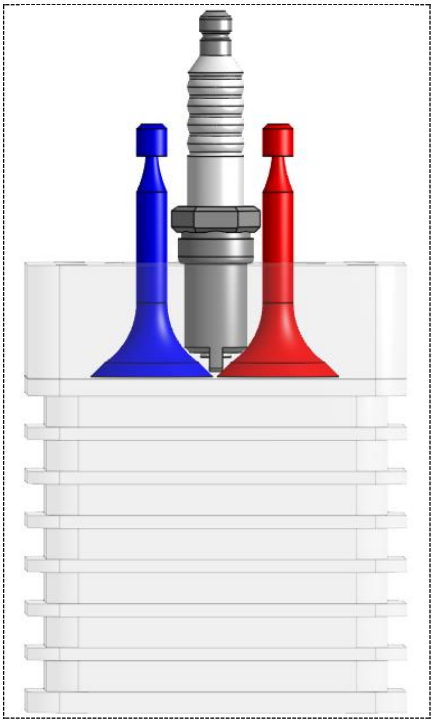


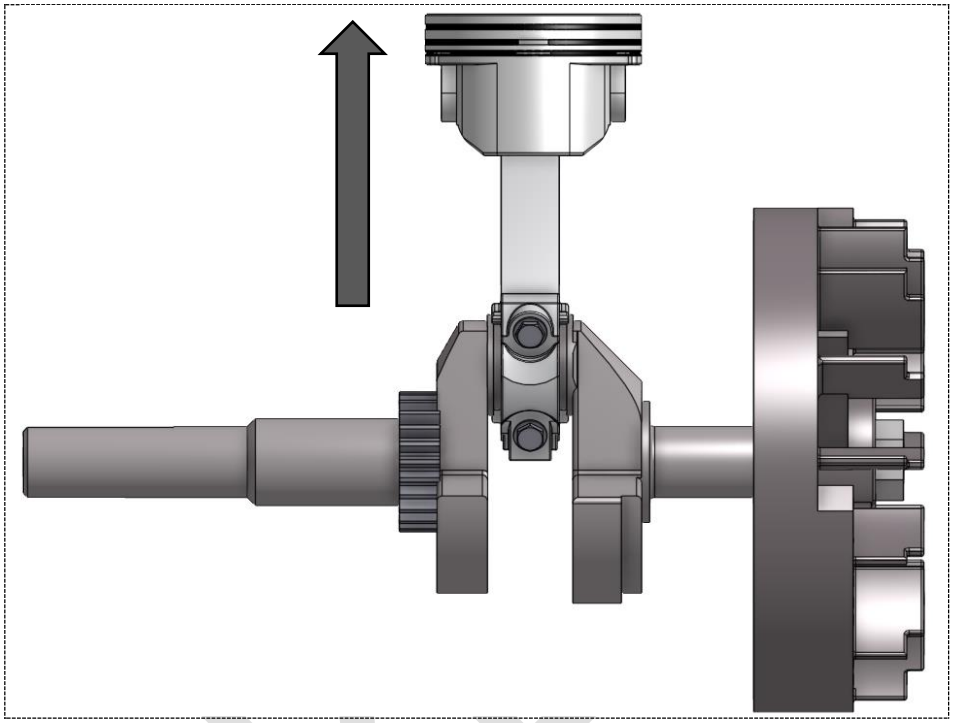


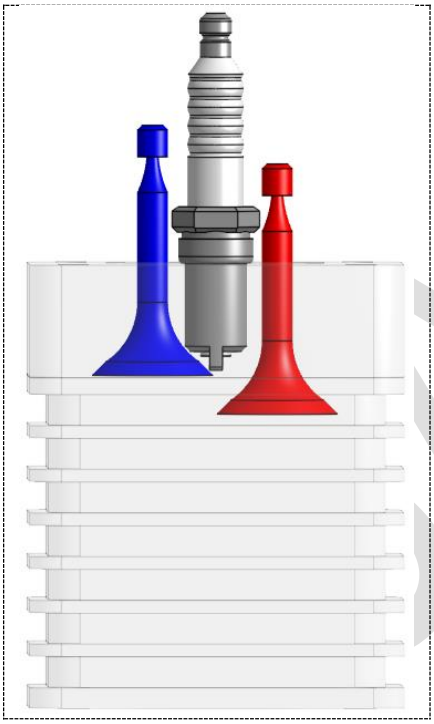


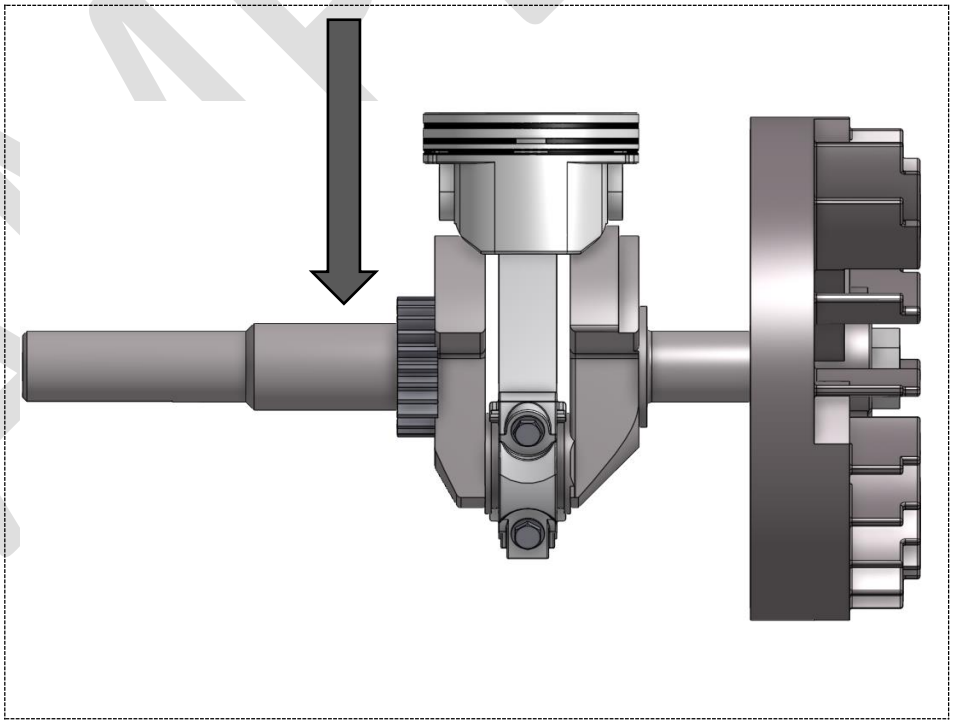


Event Images

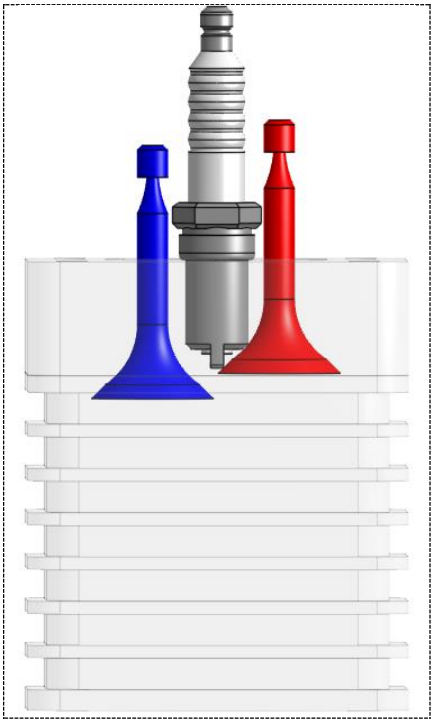


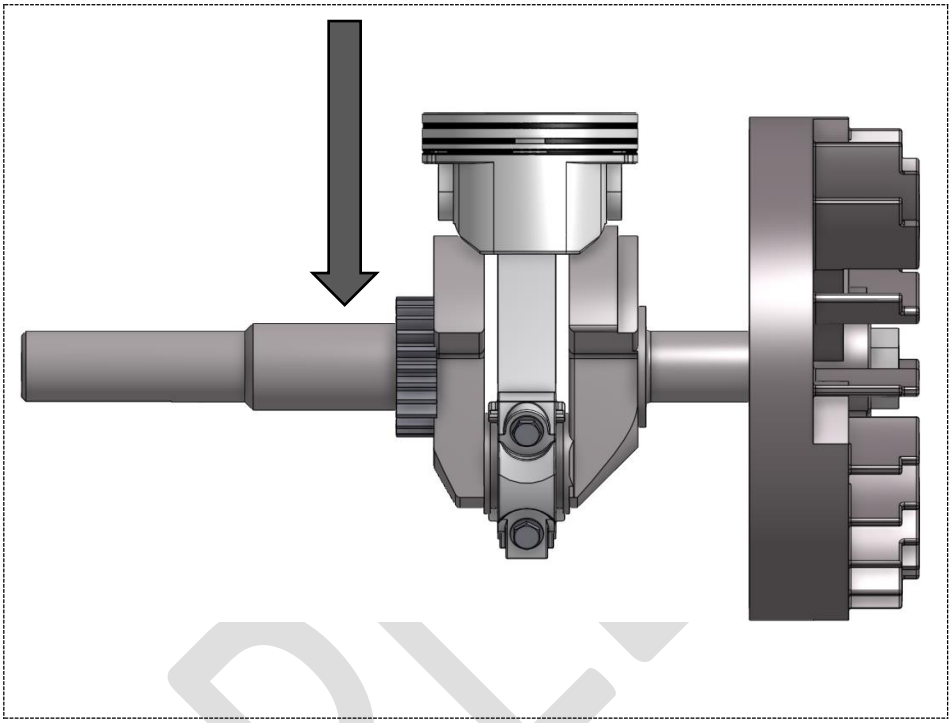






Event Images

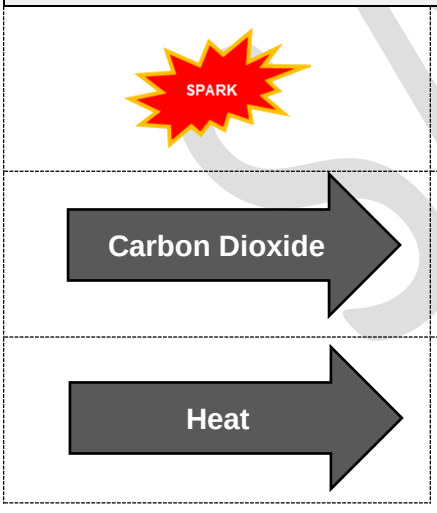




Event Headings

Compression	**Exhaust**
Ignition	**Intake**
Power	

Event Details



Event Captions
The intake and exhaust valves are closed.
The intake and exhaust valves are closed.
The intake and exhaust valves are closed.
The intake valve opens up, pulling a mixture of air and fuel from the carburetor.
The exhaust valve opens.
Engine exhaust is a mixture of water vapor, carbon dioxide, and heat.
The piston moves from Bottom Dead Center (BDC) to Top Dead Center (TDC), compressing the air-fuel mixture inside the engine cylinder.
The piston moves from Top Dead Center (TDC) to Bottom Dead Center (BDC), creating a lower pressure area.
As the piston approaches Top Dead Center (TDC), the flywheel moves past the magneto and armature, creating an electromagnet charge.
The low-pressure area creates a vacuum, pulling in a mixture of air and fuel from the carburetor.
The piston moves from Bottom Dead Center (BDC) to Top Dead Center (TDC), pushing the byproducts of combustion through the muffler.
The combustion creates pressure in the cylinder. Products include water vapor and carbon dioxide.
Pressure propels the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).
Compressive forces vaporize fuel molecules to smaller particle sizes, increasing combustibility.
The spark plug sparks in the cylinder, combusting the vaporized fuel.

case learning

CURRICULUM FOR AGRICULTURAL SCIENCE EDUCATION

Mission

To design industry-leading, inquiry-based curriculum and teacher education to create lifelong learners and prepare students for the future of agriculture.

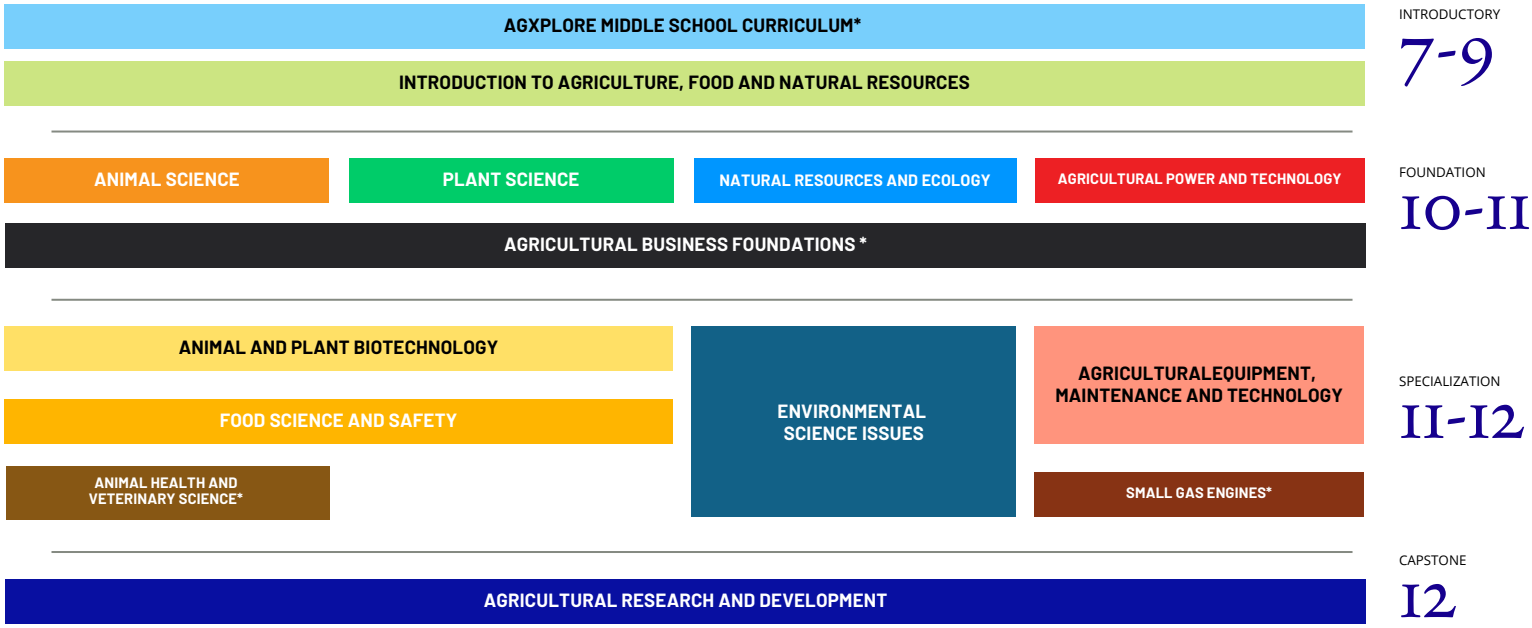
Purposeful Curriculum

CASE has sequenced courses at four levels that enhance the delivery of agricultural education through inquiry-based learning and technical skills.

Standards Aligned

CASE develops curriculum with industry feedback and aligns courses to National Agriculture, Food, & Natural Resources and Career & Technical Education standards.

Courses and Instruction Levels



Professional Development and Lifetime Certification

CASE 4 Learning enhances agricultural education with inquiry and project-based learning to prepare the next generation of the agricultural workforce through teacher certification and professional development.

CASE Institutes

Professional development events preparing teachers to implement full-year CASE courses. Institutes provide teachers the content and skills needed to use CASE curricula in their classroom. CASE Institutes range from five to eight days in a hybrid, in-person, or virtual format.

BriefCASEs *

Professional development for shortened CASE courses or modules. BriefCASEs range from one to three days.

Grants & Scholarships

Corporate sponsors and donors throughout the agriculture industry support CASE teachers through funding material implementation grants and professional development scholarships. Teachers are eligible to apply in the fall to fund their programs in the following year.

Certification

Once the teacher is certified by attending a CASE Institute or BriefCASE, they have lifetime access. There are no subscriptions or renewal fees!

In-Person
Teachers attend the entire training at the host site.

Virtual
Teachers attend the entire training online. Teachers will receive materials via mail, and are responsible for their lab space.

Hybrid
Teachers receive training both virtually and in-person based on the course.

case4learning.org

SMALL GAS ENGINES

Course Description

Small Gas Engines (SGE) introduces students to career opportunities in outdoor power equipment, diesel and agricultural equipment maintenance.

SGE introduces students to technical applications to mechanical systems, using small gas engines as the instructional tool. Students practice technical skills, including measurements, troubleshooting, documenting an engine teardown and assembly, completing work/repair orders, and reading a service manual.

This modular course can be paired with other curricula by supplementing a standard small engines or ag mechanics curriculum.

Equipping teachers

- Specialization level
- Modular course
- Inquiry and project based instructional practices
- BriefCASE professional development

Engaging students

- Disassemble and reassemble an engine
- Learn life skills for troubleshooting engines
- Technical skills prepare students for home ownership
- Careers in diesel, outdoor power equipment, and agricultural equipment maintenance

Instructional Units

- Expectations
- Diagnostics
- Safe Setting
- Equipment Safety
- Engine Operation
- Machine Assembly

Flexibility & Adaptability

CASE provides a comprehensive professional development experience, in addition to a work-life balance so teachers can best educate their students. Course work is adaptable and customizable based on teacher preference to fit all geographies and communities.

> "Small Gas Engines is designed to be teacher and student friendly. It takes students to a complete engine to one completely torn apart - they get it back together and running again with step-by-step instructions and APPs to guide them along the way."
>
> **- Grace Godfrey, Wyoming**

scan or visit case4learning.org

This course is correlated to G-W Small Gas Engines text

G-W PUBLISHER

Equipping Teachers
Engaging Students

@case4learning