AMERICA'S CAR MUSEUM

CURRICULUM GUIDE

Powerful Propulsion

(K-12th Grade)

Tour Description:

Discover how automotive technology has advanced over time to make cars faster, safer, and more fuel efficient. Compare energy sources and hypothesize which fuels may be best to power vehicles in the future.

Guiding Questions:

- What makes cars fast?
- What makes cars safe?
- What makes cars fuel efficient?

Key Concepts/Themes:

- Force and motion
- Inertia
- Safety
- Simple and complex machines
- Energy transfer and chemical reactions
- Fossil fuels and pollution
- Carbon cycle
- Renewable resources

Table of Contents

LeMAY

AMERICA'S CAR MUSEUM®

2702 East D Street, Tacoma, WA 98421

www.americascarmuseum.org

Phone: 253.779.8490

Fax: 253.779.8499

education@americascarmuseum.org

Education Department Direct Line: 253.683.3978

Possible cars that will be highlighted:

1899 Baldwin Steamer: This car is the oldest car in the collection.

1912 Standard Electric: This car is powered by fourteen 6-volt batteries and yields a top speed of 35 mph. It has a standard maximum range of 125 miles.

1918 Cadillac Type 57: This car is one of the earliest examples in the Museum of a self-starter and a V-8 engine.

1919 Stanley Steamer: This car, which is affectionately referred to as "They Flying Teapot" could go up to 75 mph, but couldn't travel more than 50 miles without having to fill up on water, which could take up to 15 minutes to heat up.

Images of these cars can be found near the end of this curriculum guide.

ACM Background Information

Brief History of Car Technology

The invention of the wheel paved the way for transportation as it is known today. Historians don't know exactly who invented the wheel, but the oldest wheel discovered thus far is believed to be over 5,500 years old. The ancient Egyptians, Indians, Greeks, and Romans improved the design of the wheel and axle, a simple machine, by adding spokes and creating a variety of wheels for different sorts of vehicles including chariots, farm carts, wagons, and passenger coaches. Until the invention of the internal combustion engine, horses and oxen were important sources of energy. The term "horsepower' is still used today to measure the power limits of machine engines. However, concerns regarding sanitation (manure) eventually led some inventors to look towards alternative forms of transportation.

In the 1700s, steam-powered vehicles, dubbed "horseless carriages," came on the market, but they didn't gain popularity until the early 1900s. In 1902, 485 of 909 new car registrations were for steamers that were powered by burning wood, coal, or oil to heat water in a boiler. The steam generated drove pistons up and down within hollow cylinders. The movement of the pistons drove the crankshaft, which ultimately turned the wheels. Eventually steamers went out of style because they had long start-up times and required frequent stops for water.

In 1899 and 1900, the sale of electric cars surpassed those of all other types of vehicles in the United States. Like electric cars today, they ran on energy stored in rechargeable batteries. These vehicles were quieter, offered a smoother ride, and were relatively odor-free. They also didn't require a long start-up time like the steam car or the considerable manual effort that was required to start a gas-powered car with a hand crank. Both steam and electric cars did not require changing gears, which was a difficult task to do in early gasoline-powered cars. However, the prominence of the electric car was destined to be short-lived as several developments shifted the advantage to gasoline-powered vehicles.

As more and more good roads were built to connect cities, the electric car's limited range eventually became a liability. That combined with cheaper gasoline (due to the discovery of oil reserves in Texas), the introduction of the conveyor belt assembly line system by Henry Ford, and the invention of the electric starter (which replaced the often dangerous hand crank) led to gasoline engines becoming more popular.

Owning a car before Henry Ford's Model T was introduced was like owning a private plane today. Once assembly line production "put America on wheels," lives changed as people took advantage of their new freedoms. Now in North America, quality of life is often defined by the power and style of our vehicles. It is important for many that cars provide a means of easy, efficient, and enjoyable transportation. However, serious concerns about air pollution from exhaust emissions and its contribution to global climate change are forcing us to consider alternatives to the internal combustion engine and gasoline fuel. Once again, electric cars are becoming popular because they offer a quieter and cleaner ride.

Possible cars that will be highlighted:

1925 Ford Model T Roadster Pickup Truck: Although the Model T Ford was introduced in 1909, it was not until 1925 that a Model T Pickup was added to the factory catalogue. The Ford Model T was the first automobile to be mass-produced in multiple countries.

1930 Duesenberg Model J: This car's straight-eight engine could produce speeds over 115 mph.

1937 Fiat Topolino: This "little mouse" Italian car used to be one of the smallest cars in the world.

1963 Chevrolet Corvette Sting Ray: This was the only year that this style featured a rear split window.

Images of these cars can be found near the end of this curriculum guide.

ACM Background Information

Introduction to the Physics of Cars

Physics is an all-embracing science that helps to explain how the world works. Learning about cars and how they work provides a unique opportunity to explore the science of physics. **Motion** is the act or process of moving from one place to another. In order for an object to move, a **force** needs to act upon it and change its motion. A force is a push or a pull on an object. How fast an object moves is called its **speed. Velocity** tells you not only the speed of the object, but also the specific direction in which the object is moving**. Acceleration** is the measure of how much the velocity of an object changes in a given amount of time. Like velocity, acceleration has both magnitude and direction. You will accelerate an object if you apply a force to it which changes its speed, its direction or both. **Mass** also affects motion. Mass is the amount of matter in an object and is generally measured in grams or kilograms. **Inertia** is the natural inclination of an object to resist changes in its state of motion. This means that if an object is not moving, it will remain motionless until a force is applied to move it. If an object is moving, it will keep moving at the same speed and in the same direction until a force is applied to change its speed, its direction or both. The greater the mass of an object, the greater its inertia will be. You will need to put more effort into moving a steel block than a wooden block because the steel block has more mass and, therefore, more inertia than the wooden block. **Friction** is the force that opposes motion when you attempt to move one object over the surface of another. Increased friction gives you better traction, and your car is better able to hold the road. Friction can also make 'work' harder. Engine parts rubbing together can create friction so that a car engine doesn't run as smoothly. Adding oil to the engine keeps engine parts coated and this reduces friction and engine wear. **Air resistance** is a type of friction that also affects the efficiency of your car. As your car moves down the road it has to push the air it encounters aside and around it. A car with a streamlined shape will have better fuel efficiency than a boxy one. **Potential energy** is energy that is stored within an object either because of its position or the way in which its parts are arranged. A car parked on the top of a hill, the chemical energy in gasoline, and a coiled spring are all examples of potential energy. **Kinetic energy** is the energy of motion. The potential energy of a car parked in neutral on a hill is transformed into kinetic energy when its emergency brake is released and the car starts moving downhill under the force of gravity. Energy can change from one form to another, but energy can neither be created nor destroyed. When your car engine burns gasoline, the chemical energy in the fuel is converted into mechanical energy. When you stop your car, your brakes change the motion of the vehicle into heat energy. That's why brake pads are made out of flame-resistant material. **Simple machines** are devices that make work easier, have few or no moving parts, and require energy to work. There are six different types of simple machines: the lever, inclined plane, pulley, wheel and axle, wedge and screw. **Compound machines** are machines that combine two or more simple machines. Many machines are complex and contain a number of parts that are meant to work together. No matter how complex a compound machine is, it is just a combination of simple machines working together. The car is an excellent example of a complex compound machine.

Possible cars that will be highlighted:

1953 Citroen 2CV: This popular French car was designed for country farmers carrying small loads of produce. It doesn't go very fast, but average fuel consumption is 50+ mpg.

1983 DeLorean DMC 12: This rear-engine vehicle has gull-wing doors and a brushed stainless steel body.

1989 Buick Regal Chattanooga Chew: During the 1989 season, Larry Pearson ran this Buick in all 29 races. Pearson, nicknamed the Silver Fox, was a 3-time NASCAR Sprint Cup champion and had 105 victories.

Images of these cars can be found near the end of this curriculum guide.

ACM Background Information

Safety on the Road

Vehicle Safety

Early cars could not reach the speeds of today's vehicles and safety wasn't a priority for many decades. In fact, early vehicles that featured seat belts were not popular. People thought that if a car needed a seatbelt, then it must not be as safe as cars without seatbelts. The first seatbelts were introduced in the late 1950s and padded dashboards and anti-lock brakes were introduced in the 1960s. Driver and passenger airbags were introduced and crash-testing began in the 1970s. It wasn't until 1984 that states began enacting passenger seat belt laws. However, during the past decade, car safety technology has not only focused on protecting people in crashes, but also preventing crashes altogether. Some new inventions include: electronic stability control (ESC), lane departure warning, collision warning with automatic braking, blind-zone warning, emergency brake assist, and adaptive headlights.

Driving Safely

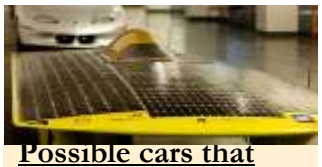
According to the National Highway Traffic Safety Administration, car crashes are the leading cause of death for children 1 to 13 years old in the United States. Using the correct type of car seat and seat belt may curb this number. However, avoiding visual, manual, and cognitive distractions is also important. In 2008, nearly 6,000 people died in crashes that involved distracted driving. Drivers must pay attention to visual and audio cues on the road to avoid a crash.

School Bus Safety

Despite the fact that most school buses do not include seat belts, school buses have been proven to be seven times safer than passenger cars or light trucks, according to the National Highway Traffic Safety Administration. Instead of seat belts, children are protected through compartmentalization by being surrounded by strong, energy-absorbing seats. Most bus-related fatalities are actually caused by motorists illegally passing a stopped school bus.

NASCAR Safety Innovations

In the early days of stock car racing, neither seatbelts nor roll bars were required. Safety requirements evolved significantly over the years. In 1952, roll bars became mandatory and in 1960, the full roll cage developed. After "Fireball" Edward Glenn Roberts, Jr. died from burns in a 1964 car crash, leak- resistant cells, flame-retardant suits, and fire extinguishers became requirements. Later in 1994, roof flaps were added to prevent cars from becoming airborne. Safety requirements expanded further after Dale Earnhardt's fatal head injury during a crash in 2001. Now, drivers must wear full-face helmets and Head and Neck Support (HANS) devices. Steel and Foam Energy Reduction (SAFER) impact-absorbing barriers have also been added to the race car track. The knowledge gained from Earnhardt's crash also informed the design of the fifth-generation Sprint Cup car, known as the "Car of Tomorrow." It features and enlarged cockpit, shock-absorbing materials, and it moved the driver to a more central location in the car.



Possible cars that will be highlighted:

2005 Momentum: This University of Michigan solar car placed first in the American Solar Challenge and placed third in the World Solar Challenge.

2009 Dodge Charger #9 Budweiser : Richard Petty Motorsports built this car for standout driver Kasey Kahne. Its *Car of Tomorrow* construction features new safety innovations.

2012 No. 5 Farmers Insurance Chevrolet: Enumclaw native Kasey Kahne drives this type of car.

2012 Toyota Prius: Toyota's "Hybrid Synergy Drive®" system combines the benefits of a gasoline engine and an electric motor.

Images of these cars can be found near the end of this curriculum guide.

ACM Background Information

Alternative Power Sources

Biofuels

Biofuels are derived from plants and are used in internal combustion engines. Growing plants to produce biofuels takes carbon dioxide out of the atmosphere. However, biofuels are less energy-dense than gasoline, so it takes more energy to store and transport them. Examples are bioethanol, which is made from the fermentation of plants like corn, and biodiesel, which is made from vegetable and animal fats. Biodiesel is safer than gasoline because it is less toxic and less flammable. Biodiesel is also preferable because using corn to produce ethanol can drive up food prices, and modern corn production is already an energy-intensive process. Vintage car owners are also concerned that using ethanol accelerates decomposition of gasket materials and seals in older engines, but there are many fine additives available to help prevent this situation.

Electric Cars

Electric cars are driven by electric motors, which are powered by energy stored in batteries. In early days of cars, electric automobiles were actually very popular because they were easier and safer to start, but preferences changed after the invention of the electric starter for gasoline-powered cars. Today, there is a resurgence of interest in electric vehicles despite the higher price of lithium-ion batteries. Advances in technology have allowed car companies to create the first mass produced electric cars such as the Nissan Leaf. In the future, it is expected that battery costs will lower, and the number of charging stations will expand. However, there are still environmental concerns with electric cars. While they don't emit pollution or greenhouse gases from a tailpipe, they rely on electricity that is often generated by coal-fired plants. These plants still pollute the atmosphere.

Hybrids

Hybrid cars combine the reduced emissions and efficiency of electric motors with the power of an internal combustion engine. Hybrids often use regenerative braking so that as the car slows, the kinetic energy is stored in the battery instead of being wasted as heat. This is why hybrids get better gas mileage in the city instead of on the highway. They can also turn off the internal combustion engine while idling. However, they can be complex and expensive due to their large lithium-ion batteries.

Hydrogen-powered Cars

Hydrogen-powered cars do not emit pollutants and greenhouse gases. Possible commercial hydrogen cars will be powered by fuel cells. Fuel cells work by stripping hydrogen atoms of their electrons, which become electricity, and combining the hydrogen ions with oxygen to form water. The cells use platinum as a catalyst which makes them the most expensive propulsion technology currently in use. Other challenges include the lack of hydrogen refueling stations, the massive energy needed to extract hydrogen from water, and the difficulty in hydrogen storage. However, despite these challenges, many experts believe that hydrogen-powered cars are the wave of the future. Honda is already leasing their FCX Clarity FCEV in California.

ACM Pre-Visit Lesson Plan #1
Car Safety Features

Learning Objective:

Students will practice visual thinking strategies that encourage them to compare and contrast the safety features of various vehicles.

Materials:

- Copies of "Car Safety Comparison" (one per student)
- Images of early unpaved roads and plank roads
- Computer and projector

Activity:

1. Display the image of the 1899 Baldwin Steamer. Introduce the car by name and then ask the following questions:
   - Describe what you see. What makes you say that?
   - What about this car makes it safe? Why?
   - What about this car makes it unsafe? Why?
   - What is it missing that could make it safer?

2. Repeat the same questions with images of the 1906 Cadillac Model M, 1909 Regal 30, and the 1930 Duesenberg Model J.

3. Show images of early roads and explain that car technology has evolved over time, just as roads. Early cars were called "horseless carriages" because they often were built by the same craftsperson and were designed to go at a similar speed as a horse-drawn carriage. The speed limit in many cities in the 1910s was 10-15 mph. Cars are much safer now, but they also go much faster than cars in the early twentieth century.

4. Today, the Insurance Institute for Highway Safety conducts a variety of tests on new vehicles to assess their occupant protection. On the Consumer Report website at http://www.consumerreports.org/cro/video-hub/cars/iihs-crash-tests/676195405001/, students can choose a car and watch its crash test video. Discuss the following questions:
   - What is the purpose of crash tests?
   - What safety features are available in cars today that were not available in earlier vehicles?
   - What could be added to cars to make them even safer?

5. Hand out the "Car Safety Comparison" worksheet to each student. Allow students to work individually or in teams to complete the sheet. Discuss student answers as a class.

Learning Objective:

Students will practice reading and demonstrate comprehension skills while becoming familiar with some of the scientific terms associated with Newton's first law of motion.

Materials:

- "The Physics of Cars - Teacher Background Information" (teacher or advanced reader resource)
- Copies of "Force and Motion" sheet (1 per student)
- Copies of "A Few Words About Force and Motion Fill-in-the Blank" (1 per student)
- Dictionary (optional)
- Pencils

ACM Pre-Visit Lesson Plan #2
Car Physics Introduction

Activity:

Use this activity to introduce new vocabulary for younger students and to review physics concepts for older students.

1. Tell students about Isaac Newton and his first law of motion.
2. Give your students a copy of "Force and Motion." Have students read individually or make an overhead transparency of the "Force and Motion" for the whole class to read together. For some students, using a dictionary may be helpful. Older students may read "The Physics of Cars - Teacher Background Information" instead.
3. Give each student the "A Few Words about Force and Motion Fill-in-the-Blank" activity to help them become more familiar with some of the words.
4. Use the answer key below to check student work.
5. Ask students to brainstorm more examples for each physics term.

Answer Key

1. ___**Gravity**_____ is a force that pulls things towards the earth.
2. A ___**push**_____ or a ___**pull**_____ can set a still object in motion.
3. A push or pull against an object in motion can ___**stop**____ it.
4. The tendency of something to keep moving or stay at rest unless a greater force stops or moves it is called ____**inertia**_____.
5. Force must be applied to put something into ___**motion**_____ or to stop it from moving.
6. The rubbing of car tires against the road is an example of ___**friction**____.
7. A ___**force**_____ is a push or a pull.

ACM Pre-Visit Lesson Plan #3
Simple and Complex Machines

Learning Objective:

In this lesson, students will learn the differences between simple and complex machines. They will be able to identify simple machines that make up complex machines.

Materials:

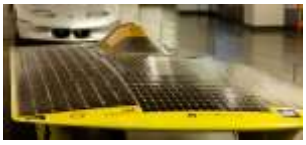
- Pencils
- Whiteboard and dry erase markers
- Copies of "Notes on Simple Machines" (one per student)
- Copies of "Notes on Complex Machines" (one for each student)
- Images of complex and simple machines
- Examples of simple machines for 6 stations (see examples under activity directions)
- Optional: document camera and overhead projector
- Optional: scissors and magazines

Activity:

1. Pass out copies of "Notes on Simple Machines" to each student. Introduce the concept of simple machines. Have students look around the classroom for examples and record their responses on a bulletin board. Instruct students to take notes on the definition of each type of simple machine.
2. Prepare stations for a rotation activity. At each station, place various examples of each type of simple machine. For example:
   - Lever: stapler, fork, plastic baseball bat, oar, rake, plier, can opener, tongs, fishing pole, tweezers, wheelbarrow, nutcracker, seesaw, and scissors.
   - Inclined Plane: makeshift ramp using board, play slide, toy dump truck, toy car with stanted windshield, and funnel.
   - Wheel and Axle: rolling pin, roller skates, toy car, manual pencil sharpener, door knob, toy steering wheel, and egg beater.
   - Screw: mason jar with lid, corkscrew, screw, lightbulb, and screw driver
   - Pulley: rope and bucket, blinds, small flag pole, bike (with chain), model sailboat.
   - Wedge: plastic knitting needles, door wedge, plastic axe, plastic knife, wedge shoes, golf club, and shark tooth.
3. Divide students into smaller groups and have them rotate between the 6 stations approximately every 5 minutes. While students are at each station, they should practice using each type of simple machine. In their notes, they should record and sketch examples of each type of simple machine.
4. Pass out copies of "Notes on Complex Machines." Explain to students that complex machines are two or more simple machines put together. Ask students to provide examples and keep a list of their responses on the whiteboard. Show images of complex machines and instruct students to sketch an image in their notes and label the simple machines that make up the complex machine. Discuss what simple machines are used on vehicles.

Optional:

1. Allow students to play a game on the Edheads Simple Machines Activities website: http://www.edheads.org/activities/simple-machines/. This asks students to identify simple machines around the house and simple machines that make up compound machines in the tool shed.
2. Hand out a variety of recycled technology and science-related magazines and allow students to cut out examples of simple and complex machines. Ask students to label their findings and then display on a bulletin board.
3. Next, watch a video about how simple machines combine to make a car. The YouTube video titled "Car Transmission and Synchromesh: 'Spinning Levers' 1936 Chevrolet Auto Mechanics" can be found online at http://www.youtube.com/watch?v=aFvj6RQOLtM&list=PLCED11EACAE477F6C&index=11.



ACM Pre-Visit Lesson Plan #4

Engine Pistons

Learning Objective:

In this lesson, students will learn about how an engine works by watching a short video about the strokes of a piston. To ensure video comprehension, they will answer questions in regards to the parts and purpose of main engine components.

Materials:

- Pencils and paper
- Laptop and overhead projector
- Whiteboard and dry erase markers
- Copies of "*How 4-Stroke Engines Work* Video Questions" (one per student or project on screen)
- Images of engine parts and four-stroke cycle

Activity:

1. To reinforce the concept of explosions inside an engine, watch the YouTube video titled "Working of 4-Stroke Engines" found at http://www.youtube.com/watch?v=SYd40qWQ9Bc .

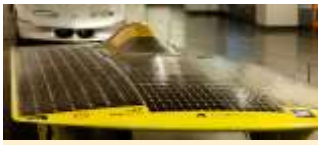
2. Display the following video questions or make copies for each student. Pause the video as needed to allow students time to write down answers. Rewind and replay if necessary. Discuss the answers, which are capitalized below. Review with the images of engine parts and the four-stroke cycle.

1. What are the basic components of every 4-stroke gas engine?
   PISTON, CONNECTING ROD, AND CRANKSHAFT

2. What are the main components of the fuel delivery system?
   INTAKE MANIFOLD, FUEL INJECTOR, SPARK PLUG, AND INTAKE/EXHAUST VALVES

3. What happens during each stroke?

   - First- Intake Stroke: THE PISTON TRAVELS DOWNWARD AS A MIXTURE OF AIR AND GAS ENTERS THE CYLINDER.
   - Second- Compression Stroke: THE PISTON TRAVELS UPWARDS, COMPRESSING THE GAS AND AIR INTO A HIGHLY COMBUSTABLE MIXTURE.
   - Third- Combustion Stroke: AFTER THE SPARK PLUG FIRES, THE PISTON IS SENT DOWNWARD FROM THE EXPANSION OF THE AIR AND GAS MIXTURE.
   - Fourth- Exhaust Stroke: AS THE PISTON TRAVELS UPWARDS, THE EXHAUST VALVE OPENS TO RELEASE THE BURNED AIR FUEL MIXTURE. WHEN THE PISTON REACHES THE TOP OF THIS STROKE, THE INTAKE VALVE OPENS AND THE CYCLE BEGINS AGAIN.



ACM Pre-Visit Lesson Plan #5
NASCAR Engine Power

Learning Objective:

In this lesson, older students will watch a National Science Foundation video about the power of a NASCAR Sprint Cup engine and will learn how the energy in fuel is converted to speed.

Materials:

- Laptop and overhead projector
- Pencil and paper
- Whiteboard and markers
- Copies of "*Science of Speed* Video Questions" (one per student)

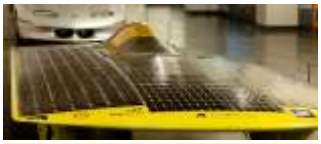
Activity:

1. Introduce the video "The Science of Speed: Power" by telling students that they will be learning how a NASCAR engine works faster and more efficiently than regular passenger car engines. The video can be found on National Science Foundation's website: www.nsf.gov/news/special_reports/sos/power.jsp.

2. Display the following video questions or make copies for each student. Pause the video as needed to allow students time to write down answers. Rewind and replay if necessary. Discuss the answers, which are capitalized below.

Answers to "*Science of Speed* Video Questions"

1. Fill in the blank. In the engine, CHEMICAL energy is converted into KINETIC energy.
2. Where is the exhaust pipe located on a race car? RIGHT SIDE
3. What is the average horsepower in a race car compared with a regular car? 850 HORSEPOWER IN RACE CAR COMPARED TO 150-200 HORSEPOWER IN REGULAR CAR
4. How are your body and an engine similar? BOTH CONVERT FUEL INTO ENERGY VIA A CHEMICAL REACTION (FOOD FOR HUMANS AND GASOLINE FOR ENGINES)
5. How is engine speed measured? REVOLUTIONS PER MINUTE – THE NUMBER OF TIMES THE ENGINE CRANKSHAFT TURNS IN 60 SECONDS
6. How much faster can a NASCAR engine run in comparison with a street car? Fill in the blanks.
    a. NASCAR engine:
        i. 9,500RPM
        ii. 38,000 combustion events
    b. Street car:
        i. 2,500 RPM
        ii. 7,500combustion events
7. Fill in the blanks. A NASCAR engine is all about HORSEPOWER. The faster the engine can convert the energy from the FUEL into MOTION through the process of COMBUSTION the more horsepower the engine has.



Learning Objective:

Students will learn how fossil fuels are created. Students will learn about the carbon cycle and demonstrate their comprehension through a visual representation and interactive simulation.

Materials:

- Large piece of coal and cup of raw oil
- Laptop and overhead projector
- Image of carbon cycle
- Paper and pencils
- Colored pencils or crayons
- Copies of "Carbon Cycle Graphic Organizer" (one sheet per student)
- Copy of "Carbon Cycle Graphic Organizer- Teacher Copy"
- Copy of "Carbon Cycle Activity- Sample Scripts"
- Optional: additional props for carbon cycle simulation

ACM Pre-Visit Lesson Plan #6
Fossil Fuels and the Carbon Cycle

Activity:

1. Show students a large piece of coal and a cup of raw oil. Ask students to explain how oil and coal is created. Explain that these natural resources are formed from carbon deposits captured in the earth and compressed over millions of years.

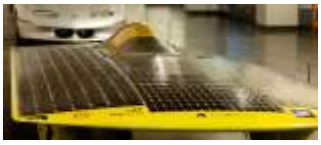
2. Ask students to explain how carbon got in the earth. Show image of carbon cycle as a clue. Discuss how carbon comes from decaying plants and animals.

3. Reinforce the concept of the carbon cycle by having students label the handout titled "Carbon Cycle Graphic Organizer." Students also have the option to draw their own visual representation of the carbon cycle.

Optional:

1. Prepare to act out the carbon cycle by having at least 6 students/teams play the parts of the sunlight, air, plants, animals, ground, and humans. Ask the participating students to create their own sign, script, and props to represent their part. Arrange participants at the front of the room as in a play and instruct them one at a time to explain their role in the carbon cycle and act out any movements, or use/hand off props, if available. See the document "Carbon Cycle Activity- Sample Scripts" for assistance.

2. For homework, as students to make a list of all the ways they use fossil fuels as a power source in their daily life.



Learning Objective:

Students will research various types of fuels and power sources and compare their advantages and disadvantages.

Materials:

- Whiteboard and markers
- Paper
- Pencils or pens
- Computers (one per student)
- Copies of "Fuel Comparison" (one per student)

ACM Pre-Visit Lesson Plan #7
Alternative Fuel Comparison

Activity:

1. Explain that no power source is completely perfect. Each has its own advantages and disadvantages.

2. Discuss petroleum (gasoline) as an example. Encourage students to brainstorm among themselves and then share with the class.

   a. Possible positives may include, but are not limited to the following: easy availability for consumers because of its well-developed infrastructure, affordable prices in comparison to hybrid and electric cars, and the employment it provides to millions of people in the oil industry.

   b. Possible negatives may include, but are not limited to the following: contamination of soil and water during extraction, danger of depleting a nonrenewable resource that can lead to competition and political conflict, and offsetting the carbon cycle when carbon dioxide is released in the atmosphere as gasoline is burned.

3. Instruct student to conduct their own research and fill in the "Fuel Comparison" graphic organizer. The "type of fuel" column is left blank so that students can generate their own answers.

4. When finished, ask students to share what they've learned. Compile a master table on the board.

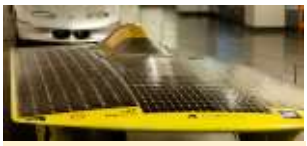
5. Ask students to vote on which type of fuel they believe will be the best choice when they become adults. Then, instruct them to write down their answer in the space provided at the bottom of the "Fuel Comparison" sheet.

Optional:

Watch and discuss the following videos on biofuels:

- How It's Made- Biodiesel, uploaded by Methes Energies on YouTube at http://www.youtube.com/watch?v=xLa83KIaEyw

- Energy 101 Biofuels, uploaded by U.S. Department of Energy on YouTube at http://www.youtube.com/watch?v=-ck3FYVNl6s



Learning Objective:

In this lesson, students will reflect on their museum visit and review the key concepts from their guided tour.

Materials:

- Whiteboard and dry erase markers
- Optional- Lined paper and pencils
- Optional: Computers for student research

ACM Post-Visit Lesson Plan
Museum Reflection

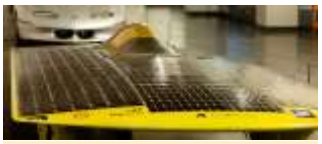
Activity:

Ask students to discuss the following questions or respond as writing prompts. Record their responses as needed on a whiteboard.

- What was your favorite thing about your museum visit?
- What was your least favorite thing about your museum visit?
- Which car was your favorite and why?
- What was the most interesting thing you learned from the guided tour?
- What simple machines combine to make a car? (Remember that simple machines include pulley, wheel and axle, screw, lever, wedge, and inclined plane.)
- Describe the purpose of each car part: fuel pump, pistons, alternator, battery, gas tank, spark plugs, starter motor, carburetor, air filter, distributer, crankshaft, timing belt, etc.
- How are car engines built differently for racing purposes?
- Which fuel do you think will be most widely used by the time you are adults?
- Which fuel do you think will be the best choice by the time you are adults?
- What are the consequences of using gasoline as a fuel type?
- What are the advantages and disadvantages of the power sources that you explored at the museum (biofuel, wind, solar, salt water, steam, electricity, etc.)?

Optional:

1. Allow students to explore the U.S. Department of Energy's Alternative Fuels Data Center website found at http://www.afdc.energy.gov/.
2. Encourage students to research the vehicle that they would like to purchase once they're able. Have them create a budget that includes saving funds for vehicle costs, fuel costs, and repair costs, etc.
3. Using recycled materials create a car that is self-powered. For example, toy cars can be built with a rubber band or balloon motor. Identify the simple machines that combined to make the toy car.
4. Have students research other parts of a car's engine.
5. Encourage students to learn more about alternative fuels by playing the Road Trip Challenge game, which is available as a free app from the Apple App Store. More information is available online at www.cdmfun.org/roadtrip-challenge.



Learning Objective:
In this lesson, students will role-play the parts of an internal combustion engine to experience how a car starts and runs.

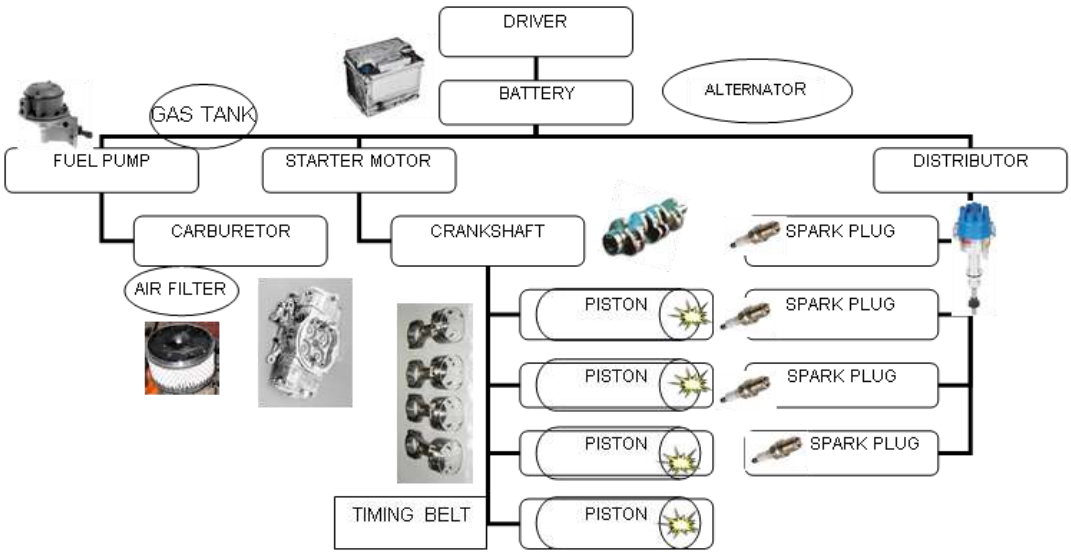
Materials:
- Copies of engine part descriptions
- Possible props:
  - key for driver
  - green signal flag for ignition
  - streamers/ribbon to signify electrical connection
  - pail for gas tank
  - black and brown craft pom poms for gas
  - white pom poms for clean air particles
  - brown, yellow, and/or gray pom poms for dirty air particles
  - red pom poms for sparks
  - pail for exhaust particles
- Optional: engine part nametags

ACM Extension Activity #1
Engine Simulation

Activity:

1. Explain to students that they will be role-playing how an internal combustion engine works. For the purpose of this activity, the part descriptions have been simplified and not all engine parts are included.
2. Determine the number of pistons and spark plugs based on the number of participants. Multiple people can help with the carburetor, battery, and distributor parts. The teacher may be the timing belt because that can be one of the most challenging parts. Hand out a role card to each student and have them find their appropriate spot (and props) in the room.
3. Allow 5-10 minutes for students to read about their engine part and practice doing their assigned task for the simulation activity (including the use of any props).
4. Regroup and ask each student to share what they've learned about their car part. Make sure that students understand when and where they are supposed to hand off an object to another person or receive an object from another person.
5. Ask the driver to start the engine. Once everyone is doing their part correctly, make it clear with a sound/video that the class was able to get the car to work. As the machine is running, have certain parts stop working. This will illustrate how the entire engine can be affected by one broken part. Ask students which parts of the car could be missing and the car would still run.
6. Ask students to switch parts and allow students to take turns being the "narrator" and explain how the car engine is working.

Overview of Layout for Engine Parts:



Learning Objective:

Students will learn through a simple experiment how carbon dioxide is different from other gases and how it relates to pollution.

Materials:

- Overhead projector or document camera
- Baking soda
- Vinegar
- Cups
- Tablespoon
- Candle
- Lighter/matches
- "Carbon Dioxide Collection in the Atmosphere" images

ACM Extension Activity #2
Fossil Fuels and Pollution

Activity:

1. To activate prior knowledge, ask students to discuss the following questions: What product is burned when gasoline (a fossil fuel) is burned? How do you think carbon dioxide is different from other gases in the air?

2. To illustrate how carbon dioxide is heavier than other gases, perform the following simple experiment:
   a. In one cup, mix a tablespoon of sodium bicarbonate (baking soda) and a tablespoon of acetic acid (vinegar) together. Through a chemical reaction, bubbles will be created that are filled with carbon dioxide.
   b. Tilt the cup filled with baking soda and vinegar over an empty cup without spilling the solution. The invisible carbon dioxide that escapes from the bubbles with pour into the empty cup.
   c. Then, tilt the cup with the invisible carbon dioxide over a lit candle. Watch as the flame is smothered. Carbon dioxide is heavier than oxygen so it prevents the flame from getting enough oxygen to burn.

   If you can't perform the experiment above, show the following YouTube video clip instead titled "Candle and Carbondioxide- Science Experiments for Kids": http://www.youtube.com/watch?v=V4P2z2RQwWs

3. Ask students the following questions: What happened when I poured carbon dioxide on the open flame? Why might too much carbon dioxide in the air be a problem?

4. Ask students to look at the satellite image on the "Carbon Dioxide Collection in the Atmosphere" document and explain why they think higher levels of carbon dioxide are found in the red, orange, and yellow areas. (Encourage them to think about the location of major cities and high populations.) Ask students to look at the smog image and explain why they think it might be dangerous to live in areas with high concentrations of carbon dioxide. Explain that because carbon dioxide is heavier than the other gases in our atmosphere, it does not allow the warm rays of the sun to escape the atmosphere at night. This can cause the carbon cycle to become off balance. Too much carbon dioxide in the air is also toxic to humans.

Optional:

Discuss how pure gasoline is a combination of hydrocarbon chemicals, which convert into carbon dioxide and water when combined with oxygen and burned. Gasoline may also contain impurities such as sulfur and can also produce carbon monoxide (which can cause death) and various nitrogen and sulfur oxides (which can cause acid rain). However, modern car engines have a secondary series of chemical reactions that cut down on exhaust pollutants.

ACM Extension Activity #3
Power Source Comparison Simulation

Learning Objective:

Students will work in teams to determine the best fuel source for a hypothetical family. Through this activity, students will weigh the convenience, affordability, reliability, and environmental effects of various power sources.

Materials:

- "Family Card Options for Power Source Comparison Simulation," cut into folded strips and placed in acontainer (to be drawn by students)
- Copies of "Power Source Comparison Simulation" (one per team)
- Computers (at least one per team/station)
- Pencils or pens

Activity:

1. Set up 5 research stations (with at least one computer) for each of the following power sources: petroleum, biofuel, electricity, hydrogen, and natural gas and propane. Provide additional research aids* to cover the following topics:
   - Convenience: How easy is it to refuel? Are refueling stations located close to your hypothetical family's location?
   - Affordability: How much does a vehicle using this power source cost? Howe expensive is it to refuel or recharge in your hypothetical family's location?
   - Reliability: Will this power source work well in your hypothetical family's location? Is this power source commonly available for the type(s) of vehicle(s) that your hypothetical family prefers?
   - Environmental Effects: What are the potentially harmful effects of extracting this power and using it to propel vehicles?

   *PowerPoint slides with images covering the research topics may be requested by emailing education@americascarmuseum.org.

2. Explain to students that they will work in teams of 2-3 students to determine which power source is best for their hypothetical family after choosing cards at random that include information about their age, size of family, location, salary, commute distance, and other factors that may influence their vehicle choice.
3. One team at a time should draw the family cards. Students should choose two salary cards if their family includes two working adults.
4. Instruct students to fill out the Part 1: Family Card Summary page of the "Fuel Comparison Simulation" worksheet. Emphasize to students that it is recommended that they purchase a car that is 20% or less of their gross annual income (based on their chosen cards).
5. When everyone has finished filling in Part I of the worksheet, instruct them to fill in the "CARE" table while rotating from one fuel station to the next, approximately every 5-10 minutes.
6. Allow groups to make their final decision in terms of the best type of power source for their hypothetical family's vehicle. Have students document their decision in the Part II section of the worksheet.
7. Ask groups to share with the rest of the class their decision in terms of vehicle type and preferred power source.

Optional:
Create more family card options and/or let students choose two different types of vehicles if they have more than one adult in their hypothetical family.

Standards Addressed

The following standards are addressed through the museum visit, pre-visit lesson plans, post-visit lesson plans, and extension activities:

Common Core State Standards (CCSS):	**Essential Academic Learning Requirements:**
English Language Arts and Literacy in History/Social Studies and Technical Subjects: **Reading:** • 1. Read closely to determine what the text is saying to make logical inferences from it; cite textual evidence when writing or speaking to support conclusions drawn from the text. • 10. Read and comprehend complex literary and informational texts independently and proficiently. **Writing:** • 2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, and analysis of content. **Speaking and Listening:** • 1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. **Language:** • 1. Demonstrate command of the conventions of Standard English grammar and usage when writing or speaking. • 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate. • 6. Acquire and use accurately a range of general academic and domain-specific words or phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level, demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.	**Math:** K.2, K.3, K.5: Patterns and Operations; Objects and their Locations; Reasoning, Problem Solving, and Communication. 1.3, 1.6: Geometric Attributes; Reasoning, Problem Solving, and Communication. 4.3, 4.5: Concept of area; Reasoning, Problem Solving, and Communication. 5.6: Reasoning, Problem Solving, and Communication. 6.4, 6.6: Two-and Three-dimensional Figures; Reasoning, Problem Solving, and Communication. 7.2, 7.6: Proportionality and Similarity; Reasoning, Problem Solving, and Communication. 8.2, 8.5: Properties of Geometric Figures; Reasoning, Problem Solving, and Communication. G.4, G.7: Two-and Three-dimensional Figures; Reasoning, Problem Solving, and Communication. **Writing:** 1. (1.5) The student understands and uses a writing process. 2. (2.1, 2.2, 2.3) The student writes in a variety of forms for different audiences and purposes. 3. (3.1, 3.2, 3.3) The student writes clearly and effectively. **Social Studies:** 3. (3.2) Geography- Understand human interaction with the environment. 4. (4.1, 4.2) History- Understands historical chronology. Uses history to understand the present and plan for the future.

Common Core State Standards (CCSS), continued:	**Essential Academic Learning Requirements, continued:**
Mathematics: Grade K: Geometry. Grade 1: Geometry. Grade 2: Geometry. Grade 4: Measurement and Data, Geometry. Grade 5: Measurement and Data, Geometry. **Next Generation Science Standards:** K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. 3-PS2-2: Make observations/measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. 4. Energy (PS3-1, PS3-2, PS3-3, PS3-4, ESS3-1). 3-5. Engineering Design (ETS1-1, ETS1-2, ETS1-3). MS. Structure and Properties of Matter (PS1-3). MS. Chemical Reactions (PS1-2). MS. Forces and Interactions (PS2-1, PS2-2). MS. Energy (PS3-1, PS3-5). MS. Matter and Energy in Organisms and Ecosystems (LS1-6, LS1-7, LS2-1, Ls2-3, LS2-4). MS. Earth's Systems (ESS2-1). MS. Weather and Climate (ESS3-5). MS. Human Impacts (ESS3-3, ESS3-4). MS. Engineering Design (ETS1-1, ETS1-2, ETS1-3). HS. Forces and Interactions (PS2-1). HS. Energy (PS3-1, PS3-2). HS. Matter and Energy in Organisms and Ecosystems (LS1-5, LS1-6, LS1-7, LS2-3, LS2-5). HS. Interdependent Relationships in Ecosystems (LS2-1, LS2-7, LS4-6). HS. Earth Systems (ESS2-2, ESS2-6). HS. Weather and Climate (ESS2-4). HS. Human Sustainability (ESS3-1, ESS3-2, ESS3-3, ESS3-4, ESS3-6). HS. Engineering Design (ETS1-1, ETS1-2, ETS1-3, ETS1-4).	**Communication**: 1. (1.1, 1.2) Student uses listening and observation skills and strategies to gain understanding. 2. (2.1, 2.2, 2.3) The student uses communication skills and strategies to interact/work effectively with others. 3. (3.1, 3.2, 3.3) The student uses communication skills and strategies to effectively present ideas and one's self in a variety of situations. **The Arts**: 1. (1.1, 1.2) The student understands and applies arts knowledge and skills in visual arts. 2. (2.1, 2.2, 2.3) The student uses the artistic process of creating, performing/presenting, and responding to demonstrate thinking skills in dance, music, theatre, and visual arts 3. (3.1, 3.2) The student communicates through the arts. 4. (4.2, 4.3, 4.4, 4.5) The student makes connections within and across the arts to other disciplines, life, cultures, and work. **Science**: K-1 INQ: Making Observations. K-1 APP: Tools and Materials. K-1 PS1: Push-Pull and Position. 2-3 SYS: Role of Each Part in a System. 2-3 INQ: Conducting Investigations. 2-3 APP: Solving Problems. 2-3 PS1: Force Makes Things Move. 4-5 SYS: Complex Systems. 4-5 INQ: Planning Investigations. 4-5 APP: Different Technologies. 4-5 PS1: Measurement of Force and Motion. 4-5 PS3: Heat, Light, Sound, and Electricity. 6 -8 SYS: Inputs, Outputs, Boundaries, & Flows. 6-8 INQ: Questioning and Investigating. 6-8 APP: Science, Technology, and Problem Solving. 6-8 PS2: Atoms and Molecules. 6-8 PS3: Interactions of Energy and Matter. 6-8 ES2: Cycles in Earth Systems. 6-8 Evidence of Change. 9-12 SYS: Predictability and Feedback. 9-12 INQ: Conducting & Analyses, Thinking Logically. 9-12 APP: Science, Technology, and Society. 9-12 PS1: Newton's Laws. 9-12 PS2: Chemical Reactions. 9-12 PS3: Transformation and Conservation of Energy.

Glossary

The following terminology is addressed through the museum visit, pre-visit lesson plans, and post-visit lesson plans:

2-D or two-dimensional: an object that is flat—having height and width.
3-D or three-dimensional: an object that has height, width, and depth and can be viewed from multiple points of view. For example: cone, sphere, hemisphere, cube, cylinder, rectangular prism, square pyramid, hexagonal prism, and triangular prism.
4-stroke engine: a four-stroke engine (as known as four-cycle) is an internal combustion engine in which the piston completes four separate strokes- intake, compression, power, and exhaust- during two separate revolutions of the engine's crankshaft, and one single thermodynamic cycle.
Acceleration: the measure of how much the velocity of an object changes over a period of time.
Air: the invisible gaseous substance surrounding the earth, a mixture mainly of oxygen and nitrogen.
Air resistance: the opposition of the atmosphere to forward movement.
Annual plant: plant grown outdoors in the spring and summer and surviving just for one growing season.
Area: measurement of surface.
Automobile: a passenger vehicle designed for use on ordinary roads and typically having four wheels and a gasoline or diesel internal-combustion engine. "Auto" means "self", "mobile" means "moving."
Axle: the pin, bar, shaft, or the like, on which or by means of which a wheel or pair of wheels rotates.
Battery: supplies the initial electrical power that starts the engine. It is made up of two lead plates plus a mixture of acid and water. This combination creates electricity that triggers the starter motor.
Biofuel: a type of fuel, made without petroleum (such as sugar cane and vegetable oil), that can be used in an ordinary internal combustion engine.
Car: a motor vehicle with four wheels; usually propelled by an internal combustion engine.
Carbon: a nonmetallic chiefly tetravalent element found native (as in diamond or graphite) or as a constituent of coal, petroleum, and asphalt, or limestone and other carbonates, and organic compounds (bodies of living things) or obtained artificially.
Carbon Cycle: the cycle of carbon in the earth's ecosystem in which carbon dioxide is fixed by photosynthetic organisms to form organic nutrients and is ultimately restored to the inorganic state (as by respiration, protoplasmic decay, or combustion).
Caution: care taken to avoid danger or mistakes.
Cellulose: a polysaccharide of glucose units that constitutes the chief part of the cell walls of plants, occurs naturally in such fibrous products as cotton and kapok, and is the raw material of many manufactured goods (as paper, rayon, and cellophane).
Centripetal Force: bends motion around into a curve.
Center of gravity: the point where the weight of an object appears to be concentrated, usually near its middle. Cars with a high center of gravity are more likely to topple over when they go around corners.
Chemical energy: that part of the energy in a substance that can be released by a chemical reaction.
Chronological: in order of time or occurrence.
Combustion: an act or instance of burning.
Combustion stroke: the stroke in the cycle of an internal combustion engine during which the piston is propelled by the pressure of the expanding steam or gases (caused by an explosion when the sparkplug ignites a mixture of gasoline and air); also known as the power stroke.
Compound machine: a device consisting of two or more simple machines working together.
Compress: to press or squeeze (something) so that it is smaller or fills less space.
Compression stroke: the stroke in a cycle of an internal combustion engine in which the gases are compressed before firing.

Connecting rod: a rod that transmits motion between a reciprocating part of a machine (as a piston) and a rotating part (as a crankshaft).
Consumer: a person who purchases goods and services for personal use.
Crankshaft: a long metal piece that connects a vehicle's engine to the wheels and helps turn them.
Distance: the amount of space between two points.
Distillation: boiling and condensing a liquid.
Design: a plan for an object or work of art.
Efficiency: the fraction of the energy that a machine uses effectively compared with how much put in. A typical gasoline engine is 30% efficient, so it uses 30% of the energy in the gasoline to move the car forward and wastes the other 70%, mostly as heat.
Electricity: a form of energy resulting from the existence of charge particles (such as electrons or protons), either statically as an accumulation or charge or dynamically as a current.
Electric Motor: a machine that uses electricity and magnetism to power an axle.
Emission: an act or instance of emitting (giving out or discharging)**.**
Energy: A source of usable power, such as petroleum or coal; usable heat or power; the capacity of a physical system to do work. Living systems (plants and animals) also need energy to function; ability of a system to do work.
Engine: A machine that turns energy into mechanical force or motion.
Environment: the whole complex of factors (such as soil, climate, and living things) that influences the form and the ability to survive of a plant or animal or ecological community.
Enzyme: protein controlling biochemical reactions; any complex chemical produced by living cells that is a biochemical catalyst.
Exhaust: waste gas or air expelled (pushed out of) from an engine, turbine, or other machine in the course of its operation.
Exhaust stroke: the movement of an engine piston (as of a 4-stroke cycle engine) that forces the used gas or vapor out through the exhaust ports.
Explosion: a violent and destructive shattering or blowing a part of something, as is caused by a bomb.
Ethanol: a colorless, flammable, easily evaporated liquid that is used to dissolve things and as fuel.
Fermentation: chemical conversion into simpler substances; the breakdown of carbohydrates by microorganisms.
Friction: a force that is trying to stop the motion of an object; the resistance encountered when one body is moved in contact with another; surface resistance to relative motion; observed when an object sliding or rolling.
Force: push or pull that gives energy to an object, causing it to start moving, stop moving, or change its motion; a force is that can cause an object with mass to accelerate.
Form: a three-dimensional object that has height, width and depth.
Fossil: remains of a plant or animal of a past age (often preserved in earth or rock).
Fossil Fuel: a fuel (as coal, oil, or natural gas) that is formed in the earth from plant or animal remains.
Freeway: and express highway with no intersections, usually having traffic routed on and off by means of a cloverleaf.
Fuel: Something consumed to produce energy. For example, a material such as wood, coal, gas, or oil burned to produce heat or power. Animals use food as fuel. Plants use energy from the sun to complete their energy process.
Fuel Cell: an electrical device powered by fuel from a tank that makes energy through a chemical reaction (similar to large battery).
Fuel injector: a device for actively injecting fuel into an internal combustion engine by directly forcing the liquid fuel into the combustion chamber at an appropriate point in the piston cycle- an alternative to a carburetor, in which an air-fuel mixture is drawn in by the downward stroke of a piston.

Fuel system: equipment in a motor vehicle or aircraft that delivers fuel to the engine.
Gasoline: A volatile (evaporates easily) mixture of flammable liquid hydrocarbons that mostly comes from crude petroleum and used as a fuel for internal-combustion engines.
Gravity: the force of attraction between all masses in the universe; especially the attraction of the earth's mass for bodies near its surface; the natural force of attraction exerted by a celestial body, such as Earth, upon objects at or near its surface, tending to draw them toward the center of the body.
Heat: a form of energy released by atoms and molecules moving around randomly.
Highway: a main road, especially one between towns and cities.
Horsepower: a unit to measure the power of engines; equal to 550 foot-pounds per second.
Hybrid car: cars with two sources of energy: an ordinary gasoline engine, powered by a fuel tank, and an electric motor, powered by batteries.
Hydrogen: a chemical element that is the simplest and lightest of all chemical elements and is normally found alone as a colorless, odorless, highly flammable gas having two atoms per molecule.
Inertia: tendency of objects to remain in motion or stay at rest unless acted upon by an unbalanced force.
Inclined plane: slanted surface used to raise an object; a plane surface inclined at less than a right angle to a horizontal surface, used to roll or slide a load up or down.
Intake: an opening by which a fluid is admitted into a container or conduit.
Intake manifold: a series of pipes which carry fuel to each cylinder in an internal combustion engine.
Intake stroke: the cycle of an internal combustion engine during which the fuel mixture is drawn in before compression.
Internal Combustion Engine: an engine in which the fuel is ignited within the engine cylinder instead of in an external furnace.
Kinetic Energy: the energy that a moving object has due to its motion; energy of motion.
Kinetic friction: friction that resists motion of an object that's already in motion.
Lignin: a substance related to cellulose that occurs in the woody cell walls of plants and in the cementing material between them.
Lever: a basic tool used to lift something or open something by lifting it out.
Load: something taken up and carried.
Machine: any device that transmits or modifies power, forces, or motion to do work; a piece of equipment with a system of parts that work together to do or make something.
Mass: the amount of something there is (amount of matter in an object).
Matter: anything that takes up space and has mass (weight).
Methane: fuel gas; a colorless, odorless, flammable gas that is the main constituent of natural gas.
Microbe: microscopic organism.
Momentum: tendency of a moving object to keep moving; mass times its velocity.
Motion: change in the relative position of the parts of anything; action of a machine with respect to the relative movement of its parts; the act or process of moving from one place to another.
Oil: refined or crude petroleum; motor oil is used to lubricate an internal combustion engine.
Oxygen: a reactive element found in water, rocks, and free as a colorless, tasteless, odorless gas which forms 21% of the atmosphere, that is capable of combining with almost all elements, and that is necessary for life.
Perennial plant: a plant that lasts for more than two growing seasons, either dying back after each season or growing continuously.
Petroleum: A thick, flammable, yellow-to-black mixture of gaseous, liquid, and solid hydrocarbons that occurs naturally beneath the earth's surface.
Physics: the branch of science concerned with the nature and properties of matter and energy. The subject matter of physics, distinguished from that of chemistry and biology, includes mechanics, heat, light and other radiation, sound, electricity, magnetism, and the structure of atoms.

Piston: a disk or short cylinder fitting closely within a tube in which it moves up and down against a liquid or gas, used in an internal combustion engine to derive motion, or in a pump to impart motion.
Pollution: the action of making something impure, especially by environmental contamination with man-made waste.
Potential energy: energy stored in an object due to its position.
Power: the energy or motive force by which a physical system or machine is operated.
Pulley: a simple machine that is used for lifting. A pulley is a wheel or set of wheels that a rope or chain is pulled over.
Push: to press upon or against (something) with force in order to move it.
Renewable: capable of being replaced by natural ecological cycles.
Restraint: the act of holding back from action; keep in check or under control.
Revolutions per minute (RPM): the measure of the frequency of a rotation commonly used to measure rotational speed. Each of the cylinders of a four-stroke engine fires once for every two revolutions of the crankshaft.
Rubber: a tough elastic polymeric substance made from the latex of a tropical plant or synthetically.
Safety: the condition of being protected from or unlikely to cause danger, risk, or injury.
Seatbelt: a belt or strap securing a person to prevent injury, especially in a vehicle or aircraft.
Screw: a metal device that fastens. You push a screw into a surface by turning it while pressing down on the head.
Shape: a 2-dimensional, enclosed space.
Simple machine: any of various devices that function in a manger basic to any machine, such as a lever, pulley, wedge, screw, or inclined plane. A simple machine is a non-motorized device that changes the direction or magnitude of a force.
Solar: of, derived from, relating to, or caused by the sun.
Spark plug: a device for firing the explosive mixture in an internal combustion engine.
Speed: the rate or a measure of the rate of motion; distance traveled divided by the time of travel; how fast an object moves.
Speedometer: an instrument on a vehicle's dashboard indicating its speed.
Static friction: friction on an object that resists making it moves.
Surface area: sum of all the areas of all the shapes that cover the surface of the object.
Tire: a ring or band of rubber placed over the rim of a wheel to provide traction and resistance to wear.
Torque: a measurement of force.
Transportation: the act of moving something from one location to another; an object that moves something from one place to another.
Valve: control consisting of a mechanical device for controlling the flow of a liquid.
Vehicle: something that transports people or objects from one place to another.
Velocity: the speed of the object moving in a specific direction.
Volume: quantity of three-dimensional space enclosed by some closed boundary**.**
Weight: response of mass to the pull of gravity.
Wedge: a piece of wood or metal shaped like a triangle with a thick edge tapering to a thin edge. A wedge is driven or forced between objects to split, lift, or make them stronger.
Wheel: a simple machine consisting of a circular frame with spokes (or a solid disc) that can rotate on a shaft or axle (as in vehicles or other machines).
Wheel and axle: a simple machine consisting of a grooved wheel turned by a cord or chain with a firmly attached axle (as for winding up a weight) together with supports.
Work: the product of a force applied to an object and the displacement of the object in the direction of the applied force.

Additional Resources

Stories for Young Readers:

Cars and Trucks and Things that Go; Scarry, Richard; Giant Golden Books, 2000
If I Built a Car, Van Dusen, Chris; Puffin Books, 2007
This Car; Collicutt, Paul; Farrar, Straus and Giroux, 2002
Mirette And Bellini Cross Niagara Falls**,** McCully, Emily Arnold; Putnam, 2000
Mirette On The High Wire**,** McCully, Emily Arnold; Putnam, 1997
Ten Apples Up On Top!, LeSieg, Theo; Random House, 1961
Tug-of-War: All About Balance**,** Hall, Kiarsten; Children's Press (Beastieville Series), 2004
Up And Down On The Merry Go Round**,** Archambault, John; Henry Holt, 1991

Non-fiction Books for Young Readers:

A History of Cars, Corbett, David; Gareth Stevens Publishing, 2005
Around and Around, Murphy, Patricia J.; Scholastic Library, 2002
Back and Forth, Murphy Patricia J.; Scholastic Library, 2002
CAR, Sutton, Richard and Baquedano Elizabeth; DK (Eyewitness Series), 2005
Car Smarts: Hot Tips for the Car Crazy, Edmonston, Phil and Sawa, Maureen; Tundra Books, 2003.
Experiments with Motion**,** Tocci, Salvatore; Children's Press (True Book Series), 2003
Force and Motion; Delta Education
Full of Energy, Hewitt, Sally; Children's Press, 1998
How Do You Lift A Lion?, Wells, Robert E.; Albert Whitman, 1996
I Fall Down, Cobb, Vicki; HarperCollins, 2004
Inclined Planes, Dahl, Michael S.; Capstone Press, 1996
Learn about the Way Things Move, Gold-Dworkin, Heidi; McGraw-Hill, 2000
Machines We Use, Hewitt, Sally; Children's Press, 1998
Make It Move!, VanVoorst, Jennifer; Capstone Press, 2004
Motion, Farndon, John; Benchmark Books, 2002
Motion and Movement**,** Frisch, Joy; Smart Apple Media, 2003
Pulleys, Dahl, Michael S.; Capstone Press, 1996
Push and Pull, Schaefer, Lola M. & Gail Saunders-Smith; Capstone Press, 1999
Simple Machines, Fowler, Allan; Scholastic Library, 2001
Up and Down, Murphy, Patricia J.; Lerner (Rookie Read-About Science Series), 2004
The Automobile **(Great Inventions),** Lincoln Collier, James; Benchmark Books (NY), 2005
The Ways Things Move**,** Nelson, Robin; Lerner, 2004
The Way Things Work**,** Macaulay, David; Dorling Kindersley Publishers Ltd;
The World of Science, Parragon Publishing; 2007
What Makes A Magnet?, Branley, Franklyn M.; HarperCollins, 1996
What's Faster than a Speeding Cheetah?, Wells, Robert E.; Albert Whitman, 1997
Whirlers and Twirlers: Science Fun with Spinning, Cobb, Vicki; Lerner, 2001

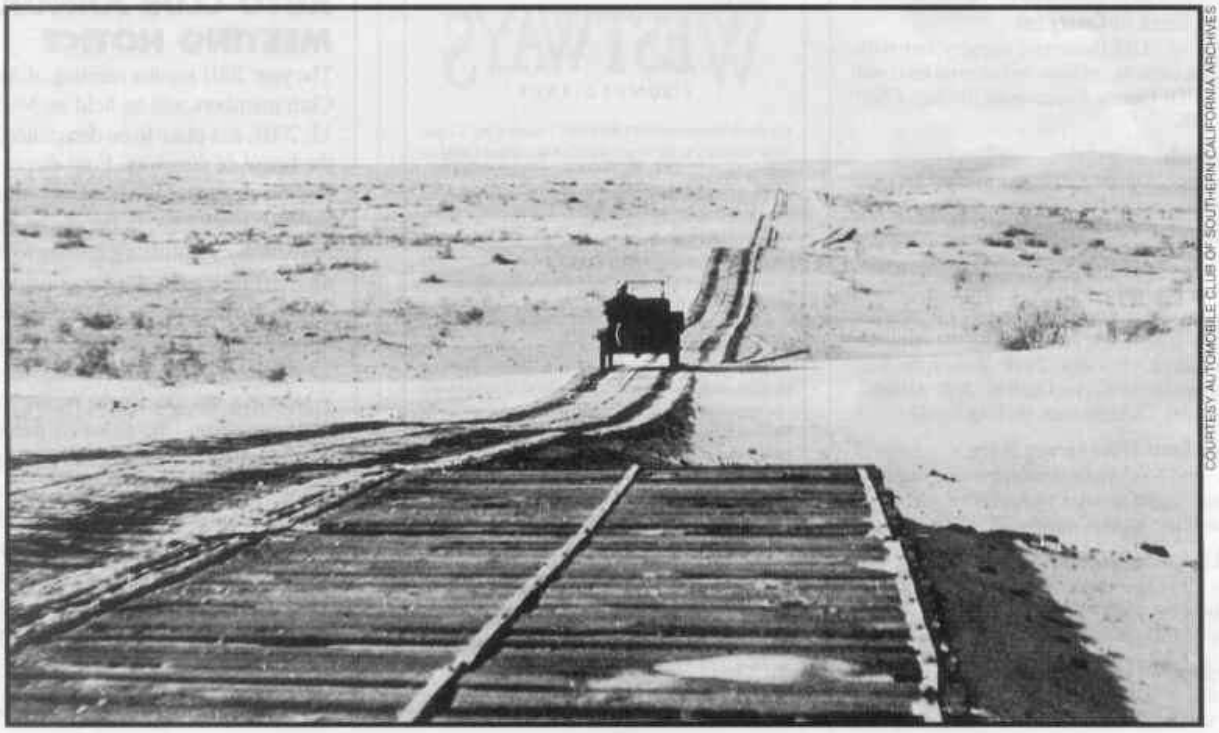
Additional Non-fiction Books:

Ancient Machines: From Wedges to Waterwheels, Woods, Michael & Mary B. Woods; Lerner, 1999
Armored Car: A History of American Wheeled Combat Vehicles: R.P. Hunnicutt, Presidio Press, 2002
Arsenal of Democracy: The American Automobile Industry in World War II (Great Lakes Books Series), Charles Hyde, Wayne State University Press, 2013

Automotive Technology: Principles, Diagnosis, and Service: James D. Halderman, Prentice Hall, 2011
***Awesome Experiments in Force and Motion*,** DiSpezio, Michael; Sterling Publishing Co., Inc., 2006
British Sports Cars of the 1950s and 60s: James Taylor, Shire, 2014
Car Smarts: Hot Tips for the Car Crazy, Edmonston, Phil and Sawa, Maureen; Tundra Books, 2003.
Classic British Cars: The History of Ten Legendary Car Companies: Jonathan Wood, Bounty Books, 1995
Driving with the Devil: Southern Moonshine, Detroit Wheels, and the Birth of NASCAR: Neal Thompson, Broadway Books, 2007
Duesenberg: Dennis Adler, Krause Publications, 2004
Engines of Change: A History of the American Dream in Fifteen Cars: Paul Ingrassia, Simon & Schuster, 2013
Fifty Cars That Changed the World: Andrew Nahum, Conran Octopus, 2009
Force and Motion, FlashKids Editors; Spark (Flashcharts Series), 2004
Forces and Motion, De Pinna, Simon; Raintree, 1998
Forces, Mole, Karen Bryant, Rigby Interactive Library, 1997.
Hip to the Trip: A Cultural History of Route 66: Peter Dedek**,** University of New Mexico, 2007
How Cars Work, Newton, Tom; Black Apple Press, 1999
Janice VanCleave's Machines: Mind-Boggling Experiments You Can Turn into Science Fair Projects, Pratt VanCleave, Janice; Wiley and Sons, 1993
Modern Automotive Technology 7th Edition: James E. Duffy, Goodheart-Willcox, 2009
Motor City Muscle: The High-Powered History of the American Muscle car: Mike Mueller, Motorbooks, 2011
My Life & Work – An Autobiography of Henry Ford: Henry Ford, CreateSpace Independent Publishing Platform, 2013
Packard: A History of the Motor Car and the Company (Automobile Quarterly Magnificent Marque Books): Beverly Kimes, Austomobile Quarterly, 2005
Powering the Future: How We Will (Eventually) Solve the Energy Crisis and Fuel the Civilization of Tomorrow: Robert Laughlin, Basic Books 2013
***Science Experiments with Forces*,** Nankivell-Aston, Sally; Franklin Watts, 2000
Spinning Blackboard and Other Dynamic Experiments on Force and Motion, Doherty, Paul & Don Rathjen; Wiley and Sons, 1996
The All-American Muscle Car: The Birth, Death and Resurrection of Detroit's Greatest Performance Cars: Jim Wangers, Motorbooks, 2013
The American Car Dealership: Robert Genat, Motorbooks International, 1999
The Arsenal of Democracy: FDR, Detroit, and an Epic Quest to Arm an America at War: A.J. Baime, Mariner Books, 2015
The Car Care Book 3rd Edition: Ron Haefner, Delmar Cengage Learning, 2008
The Complete Book of Classic Ford F-Series Pickups: Every Model from 1948-1976 (Complete Book Series): Dan Sanchez, Motorbooks, 2014
The People's Tycoon: Henry Ford and the American Century: Steven Watts, Vintage, 2006
The Physics of Nascar: The Science Behind the Speed: Diandra Leslie-Pelecky, Plume, 2009
***The Way Things Work*,** Macaulay, David; Dorling Kindersley Publishers Ltd, 1990
The World of Science, Parragon Publishing; 2007
***Wedges*,** Welsbacher, Anne; Capstone Press, 2001
Wizard: The Life and Times of Nikola Tesla : Biography of a Genius (Citadel Press Book): Marc Seifer, Citadel, 2001

Images of early unpaved roads:

Images of Plank Road:



A motorist negotiates the Plank Road through the Algodones Dunes, circa 1919. The platform in the foreground is a turnout, which allowed drivers to pull over so cars coming from the opposite direction could pass.

Name: _____ **Date:** _____

Car Safety Comparison

Directions: Look closely at the two images below. Then, make a list of things that look safe or unsafe about each vehicle.

1906 Cadillac Model M		**2012 No. 5 Farmers Insurance Chevrolet**	
			
What looks unsafe?	**What looks safe?**	**What looks unsafe?**	**What looks safe?**

5. Between the two cars, which one do you think is more safe and why?

_____

_____

_____

Force and Motion

What is a force?

A **force** is a push or a pull on an object. A push or a pull can set a still object in motion and likewise, a push or pull against an object in motion can **stop** it. If you push a toy car to make it move, the push is the force that made the car roll. If you pull the car to you, the pull is the force that made the car roll back to you.

What is motion?

When something is not sitting still, it is in **motion.** In order to put the car in motion, you must apply a force. If you push the car it begins to **move** and is in motion. Once in motion, a force must be applied to make it stop. For example, if the car hits a wall, the wall applies a force that stops the car from moving.

What is inertia?

The tendency of something to keep moving or stay at rest, unless a greater force stops or moves it, is called **inertia**. Imagine riding a skateboard down a hill. If you pushed off and coasted down the hill you would keep going until you hit something that would make you slow down or stop.

What is friction?

Friction is a force that slows things down. An example of friction is the rubbing of car tires against the road as it moves forward. When a road is covered in ice, there isn't as much friction between the tires and the ice. This is why cars can slide out of control when driving on ice. By adding rough sand on top of the ice, a car's tires can hold on to the road better because there is more friction between the tires and sand than there is between the tires and ice.

What is gravity?

Gravity is a force that pulls all things towards the earth**.** It keeps your feet on the ground unless another force pushes or pulls you off of the ground. Gravity is what helps pull your bike down a hill and it is why you pick up speed as you continue down the hill. It is also what makes it harder for you to ride uphill.

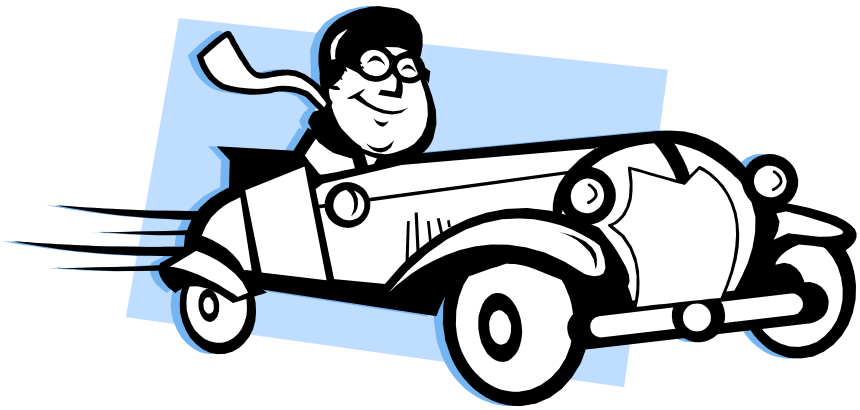
Name: _____ Date: _____

A Few Words about Force and Motion

Fill-in-the-Blank

Fill in the blanks in the sentences below using the bolded words in the reading assignment "Force and Motion":

1. _____ is a force that pulls things towards the earth.
2. A _____ or a _____ can set a still object in motion.
3. A push or pull against an object in motion can _____ it.
4. The tendency of something to keep moving or stay at rest unless a greater force stops or moves it is called _____.
5. Force must be applied to put something into _____ or to _____ it from moving.
6. The rubbing of car tires against the road is an example of _____.
7. A _____ is a push or a pull.



Name: _____Date: _____

Notes on Simple Machines

Name of Simple Machine	Definition	List of Examples	Sketch of an Example
Lever			
Inclined Plane			
Wheel and Axle			
Screw			
Pulley			
Wedge			

Name: _____Date: _____

Notes on Complex Machines

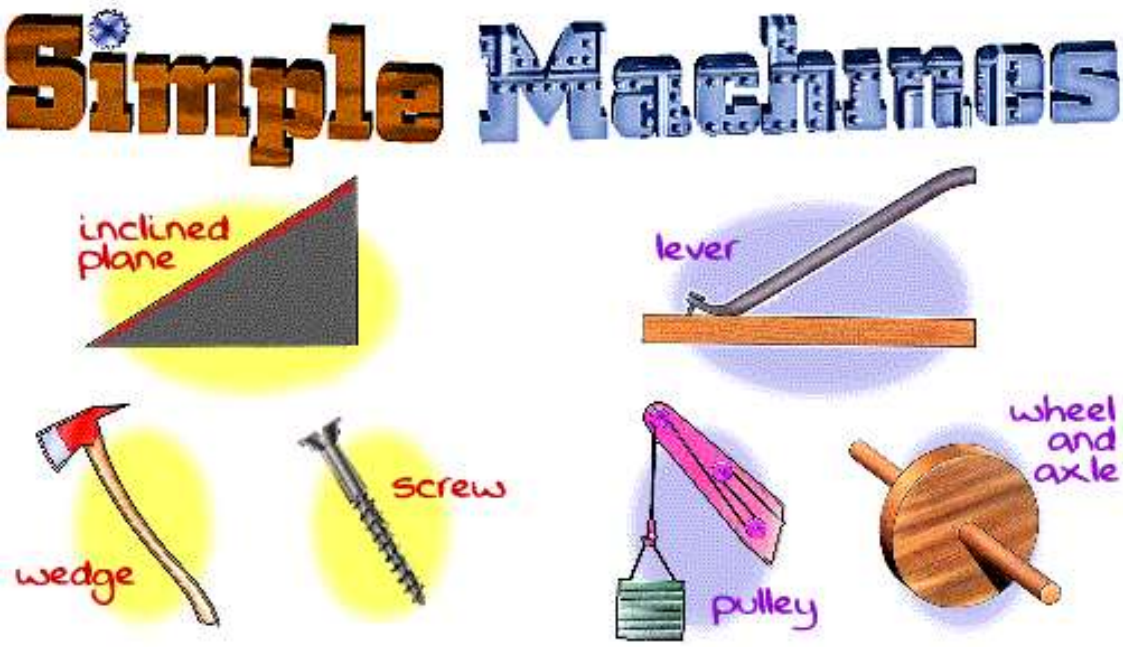
Definition of Complex Machine:

_____

_____

_____

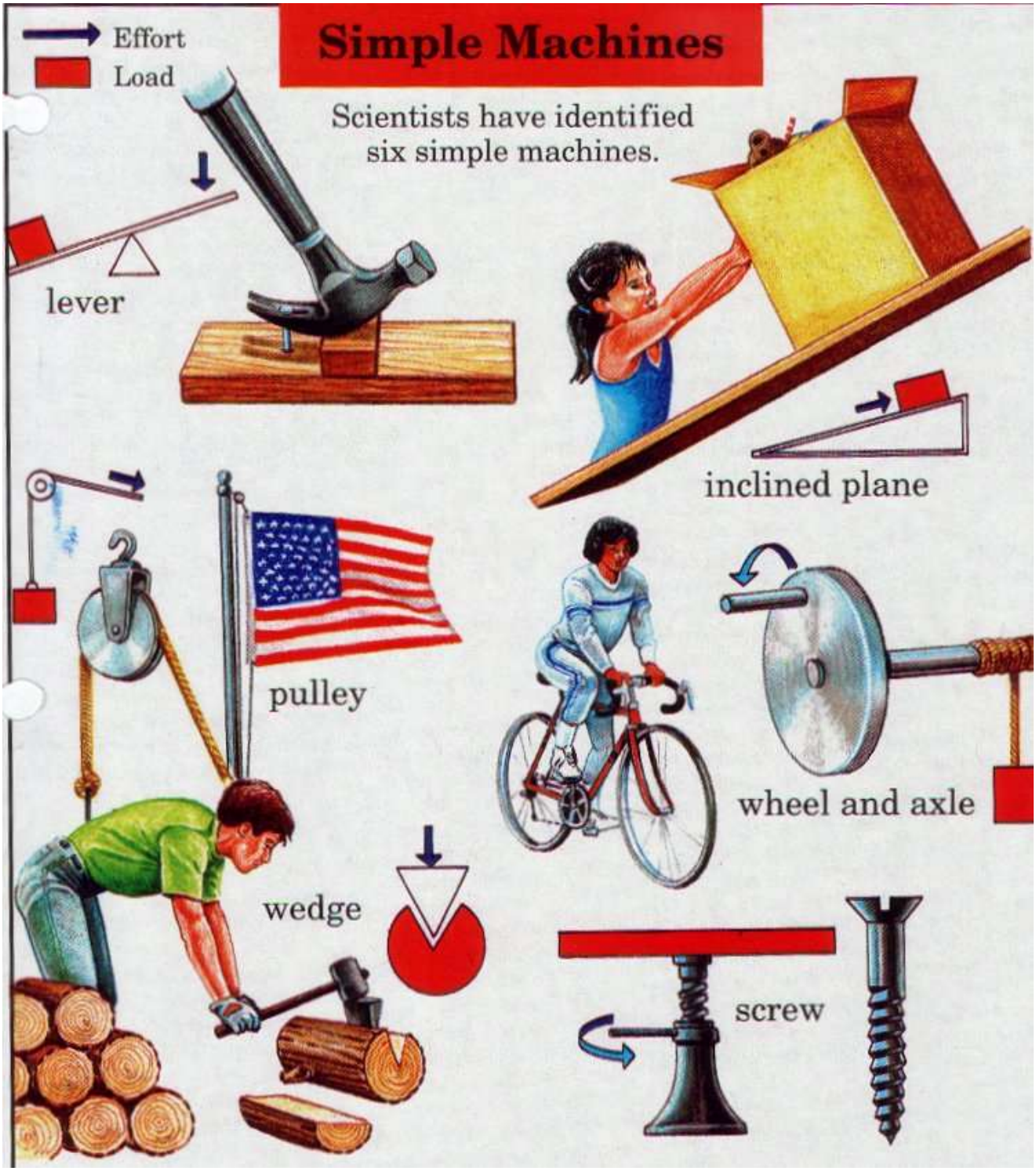
Draw a complex machine. Then, label the simple machines that make up the complex machine.



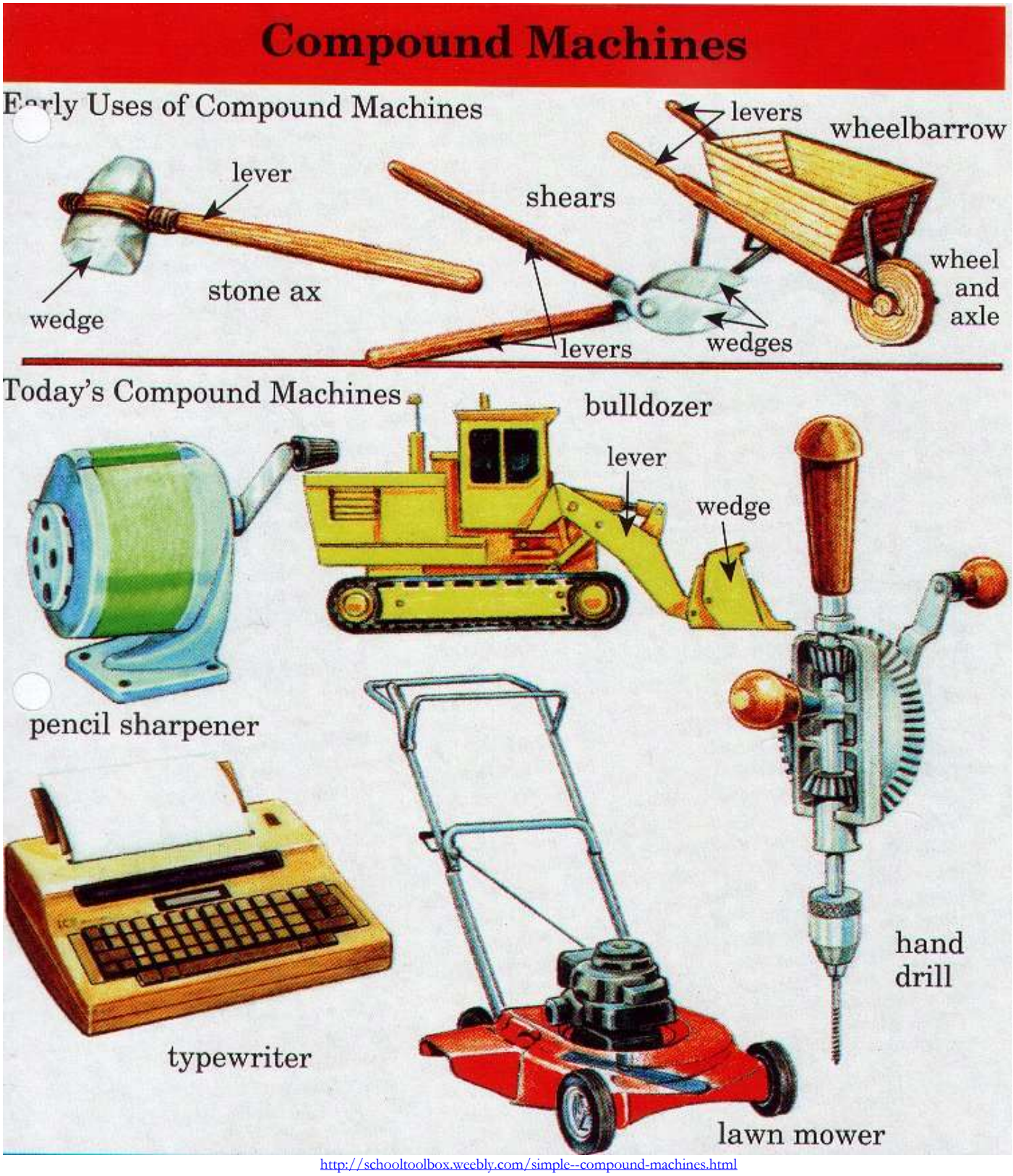
9

7/spotlight3/inline/simplemachines.gif

schooltoolbox.weebly.com



http://www.laurensieben.com/spain/?p=837



http://schooltoolbox.weebly.com/simple--compound-machines.html

http://bicycletutor.com/guide/

http://learningideasgradesk-8.blogspot.com/2011/05/complexcompound-machines.html

Name: _____ Date: _____

How 4-Stroke Engines Work Video Questions

4. **What are the basic components of every 4-stroke gas engine?**

5. **What are the main components of the fuel delivery system?**

6. **What happens during each stroke?**
   - **First- Intake Stroke:**
   - **Second- Compression Stroke:**
   - **Third- Combustion Stroke:**
   - **Fourth- Exhaust Stroke:**

Name: _____ Date: _____

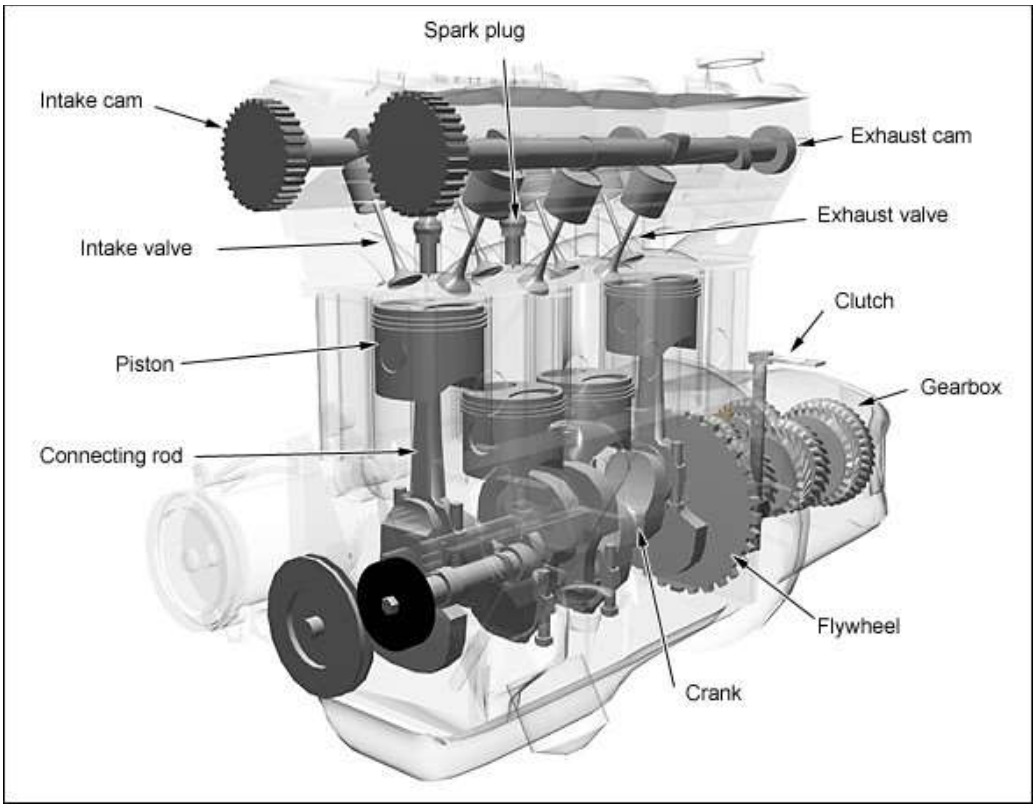
How 4-Stroke Engines Work Video Questions

1. What are the basic components of every 4-stroke gas engine?

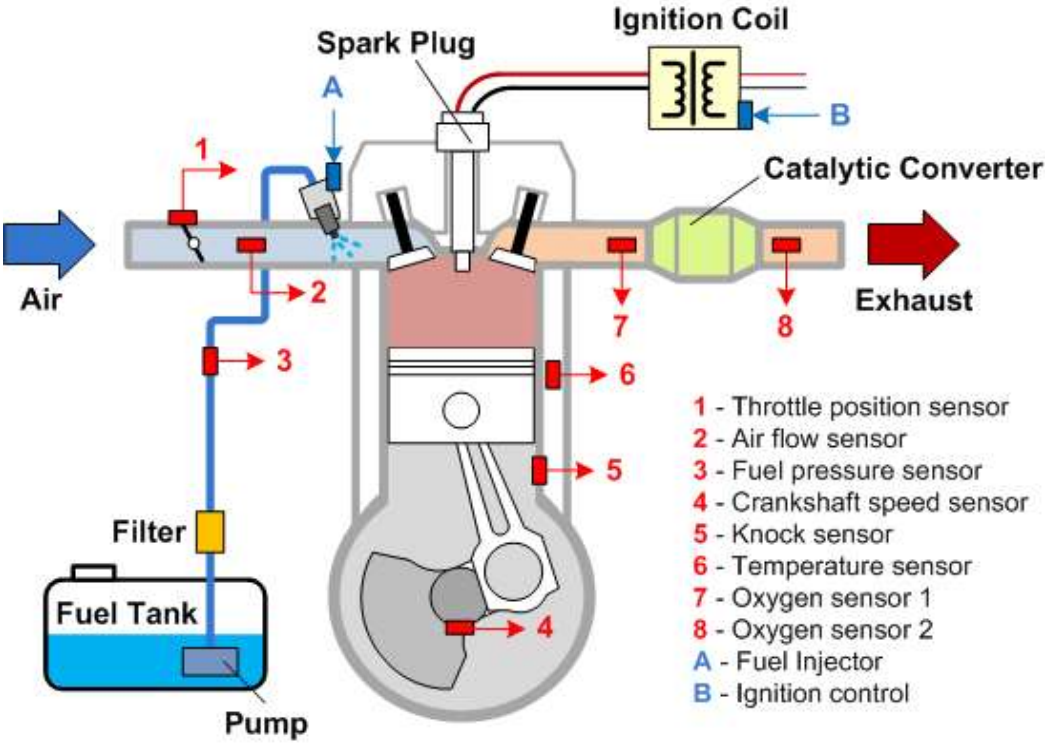
2. What are the main components of the fuel delivery system?

3. What happens during each stroke?

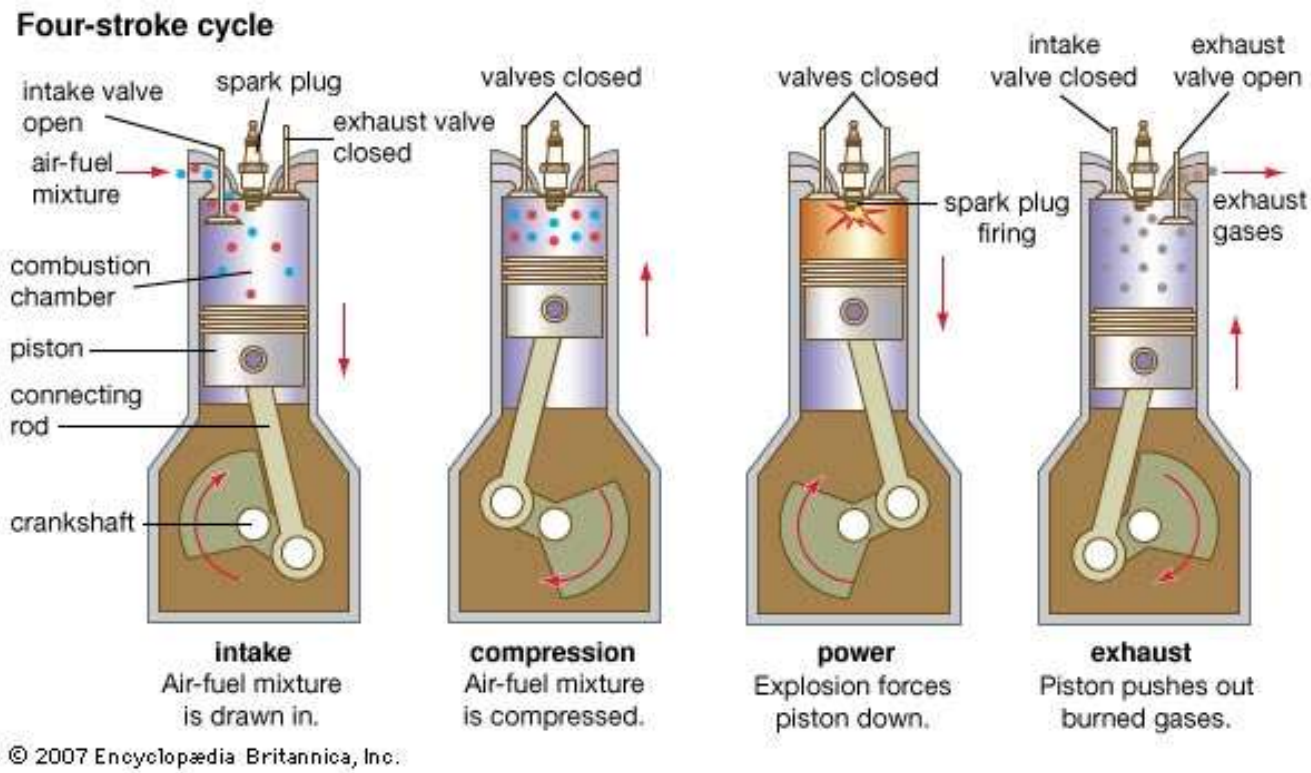
- **First- Intake Stroke:**
- **Second- Compression Stroke:**
- **Third- Combustion Stroke:**
- **Fourth- Exhaust Stroke:**



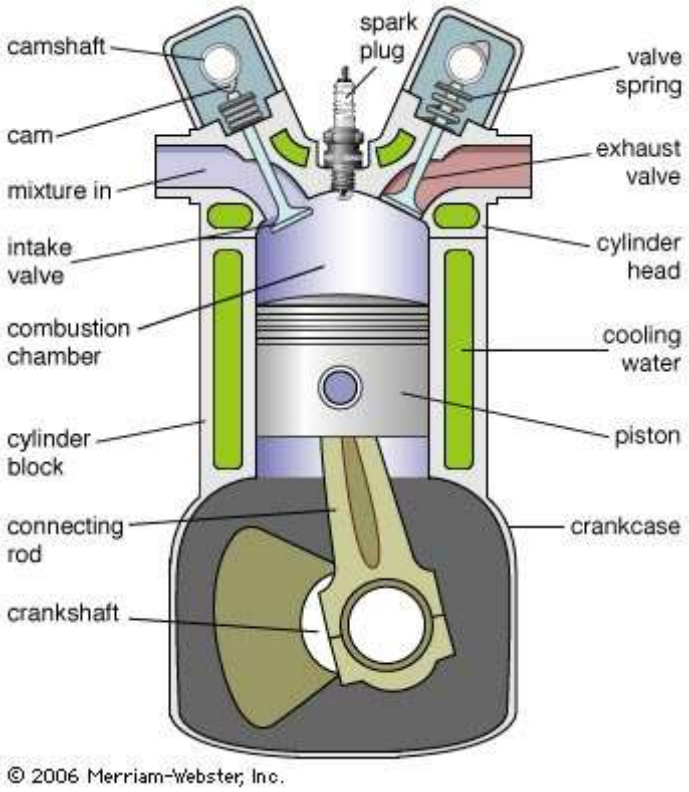
http://www.nomenclaturo.com/tag/gasoline-engine



www.cvel.clemson.edu/auto/systems/engine_control.html



www.turbodriven.com



gicl.cs.drexel.edu

Name: _____ Date: _____

Science of Speed Video Questions

8. **Fill in the blank. In the engine, _____ energy is converted into _____ energy.**

9. **Where is the exhaust pipe located on a race car?**

10. **What is the average horsepower in a race car compared with a regular car?**

11. **How are your body and an engine similar?**

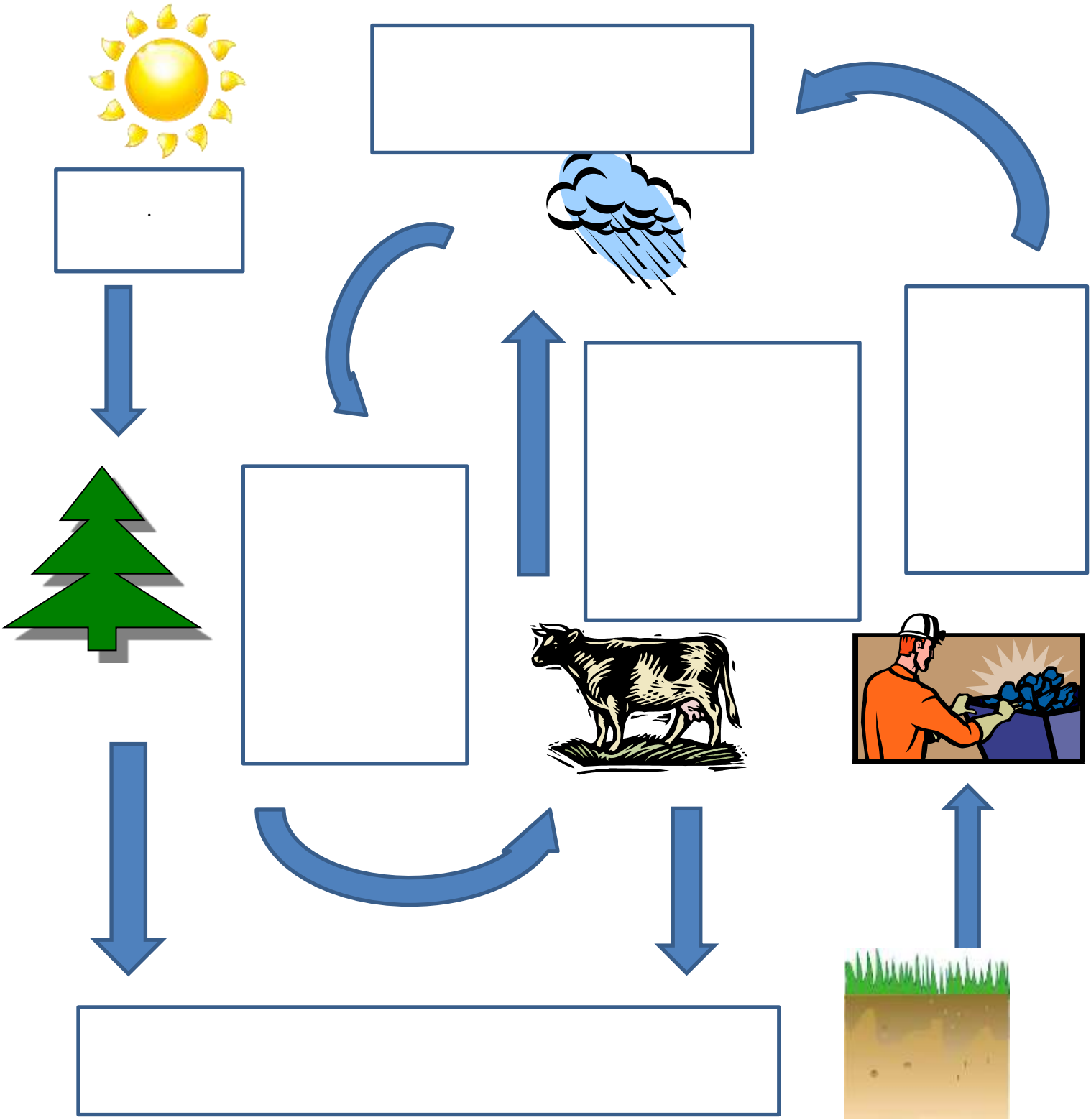
12. **How is engine speed measured?**

13. **How much faster can a NASCAR engine run in comparison with a street car? Fill in the blanks.**
    a. **NASCAR engine:**
        i. **_____RPM**
        ii. **_____combustion events**
    b. **Street car:**
        i. **_____RPM**
        ii. **_____combustion events**

14. **Fill in the blanks. A NASCAR engine is all about _____. The faster the engine can convert the energy from the _____ into _____ through the process of _____ the more horsepower the engine has.**

Name: _____ Date: _____

Carbon Cycle Graphic Organizer

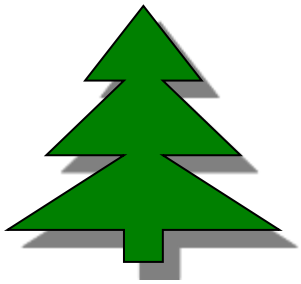


Carbon Cycle Graphic

Carbon Cycle Graphic Organizer- Teacher Copy

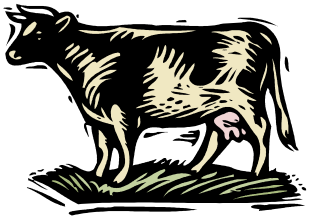
SUNLIGHT:
Sunlight provides energy for plants.

AIR:
Air is a mixture of gases. Plants use carbon dioxide and make oxygen. Animals use oxygen and make carbon dioxide.

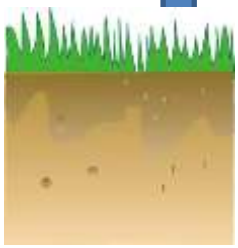


PLANTS:
Through photosynthesis, plants take water and carbon dioxide and use it to make sugar. In the process, plants give off oxygen, which is breathed in by humans and animals.

ANIMALS:
Animals (including humans) consume carbon atoms in food and breathe in oxygen. The oxygen and carbon atoms join to make carbon dioxide, which is released into the atmosphere when breathed out.

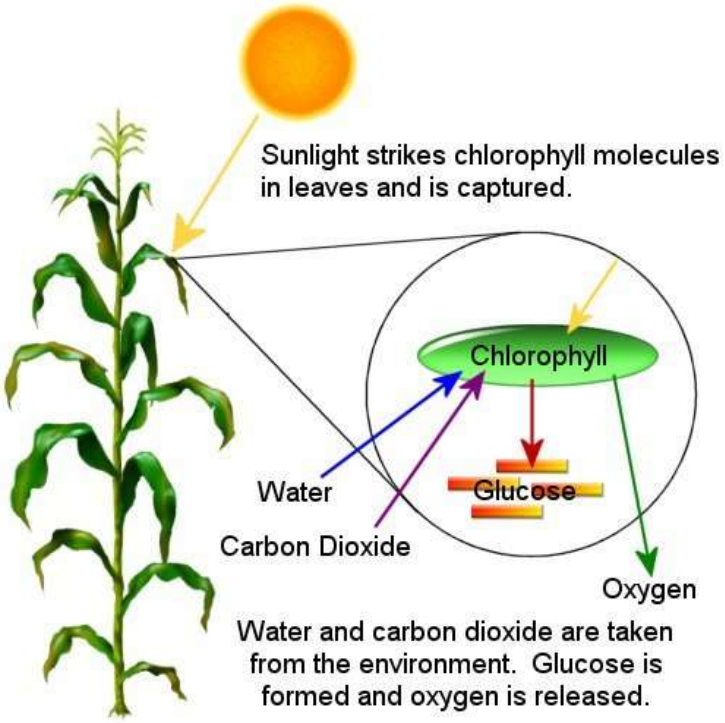


HUMANS:
When coal and oil are burned as fuel for humans, carbon is released into the air. It combines with oxygen to make carbon dioxide.

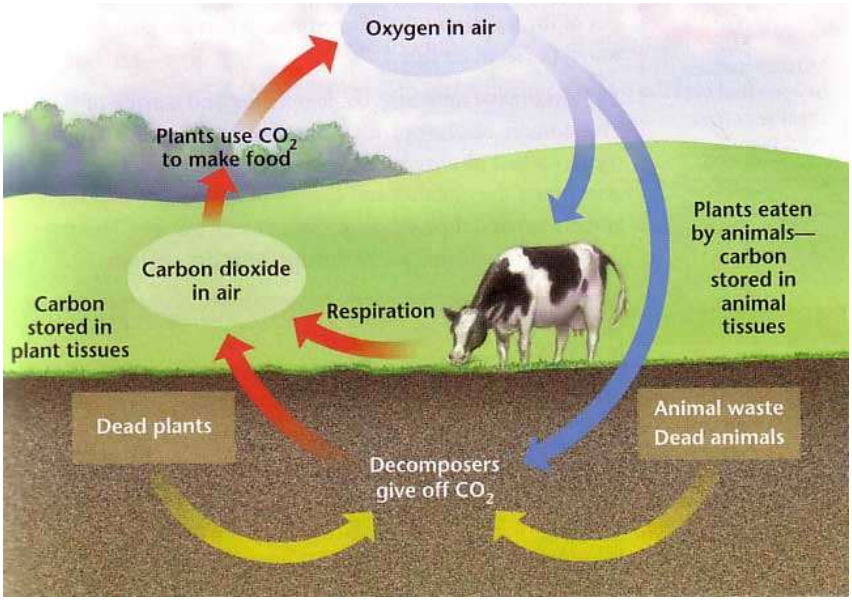


GROUND:
When plants and animals die, they decay and the carbon in their tissue will eventually become fossil fuels. Examples of fossil fuels include coal and petroleum.

Photosynthesis



Source: http://teachers.moed.bm/leone.samuels/Photosynthesis%20Diagrams/Photosynthesis.jpg



Source: http://ykonline.yksd.com/distanceedcourses/Courses/Biology/lessons/SecondQuarterLessons/Chapter7/7-3/Images/OxygenCycleP153.jpg

Carbon Cycle Activity - Sample Scripts

Sunlight: I provide energy to plants so that they can use carbon dioxide (from the air) and water to make sugar.

(Possible props could include signs/symbols for light and energy (such as a light bulb).

Plants: Through photosynthesis, I take in water and carbon dioxide and use energy from the sun to make sugar. In the process, I give off oxygen, which is vital for humans. When I die, my body will decay and the carbon in my tissue will eventually turn into fossil fuels.

(Possible props could include signs/symbols for energy, sugar, water, carbon dioxide, carbon, oxygen, and death/decay.)

Animals: When I consume food (which contains carbon atoms in plants and animals) and breathe oxygen, the oxygen and carbon atoms join and make carbon dioxide, which I breathe out. This chemical reaction is converted into kinetic energy and heat. When I die, my body will decay and the carbon in my tissue will eventually turn into fossil fuels.

(Possible props could include signs/symbols for eating (such as plate and utensils), carbon, carbon dioxide, oxygen, and death/decay.)

Air: I am a mixture of gases including 78% nitrogen, 21% oxygen, and traces of water vapor, carbon dioxide, and other components. Plants use the carbon dioxide to make sugar and give off oxygen. Animals breathe in the oxygen and breathe out carbon dioxide.

(Possible props could include signs/symbols for oxygen and carbon dioxide.)

Humans: When I burn fossil fuels (such as coal and petroleum products) for fuel, carbon is released into the air. It combines with oxygen to make carbon dioxide.

(Possible props could include signs/symbols for fossil fuels, carbon, oxygen, and carbon dioxide.)

Ground: When plants and animals die, I absorb the carbon from their decaying bodies. Through a process that takes millions of year, I turn them into fossil fuels such as coal and petroleum.

(Possible props could include signs/symbols for death/decay, carbon, and fossil fuels.)

Name: _____Date: _____

Fuel Comparison

Directions: As you research vehicle power sources, keep track of the advantages and disadvantages of each type of fuel.

Type of Fuel	Advantages	Disadvantages

What is the type of fuel you believe will be the best choice when you become an adult? Why?

_____

_____

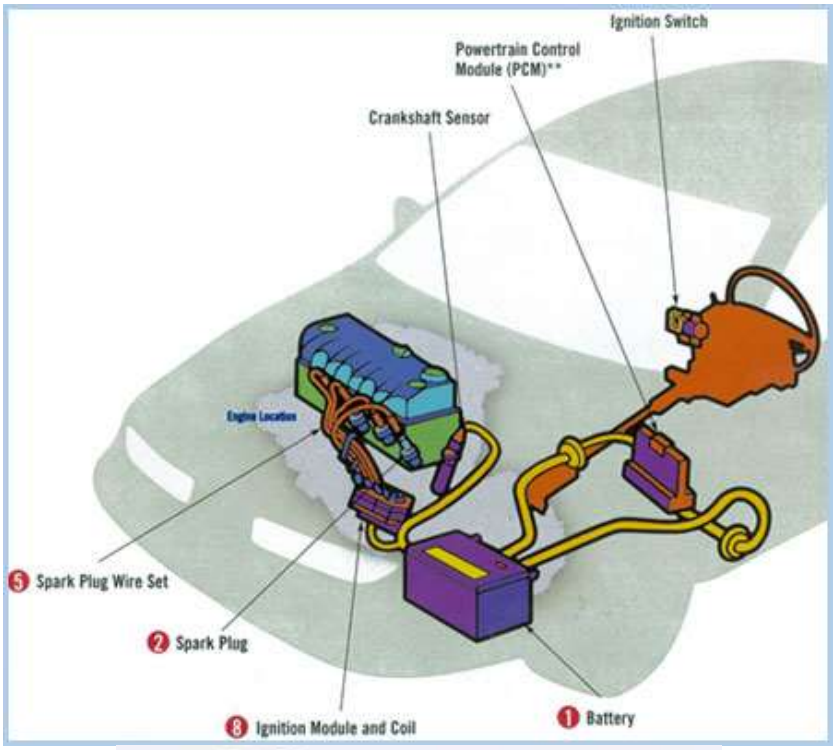
_____

Driver

What's your part during the activity?

- When the teacher tells you to begin, pretend to sit in a car seat, buckle a seat belt, and start a car.
- To symbolize turning a key in the ignition, hand the key to the ignition.

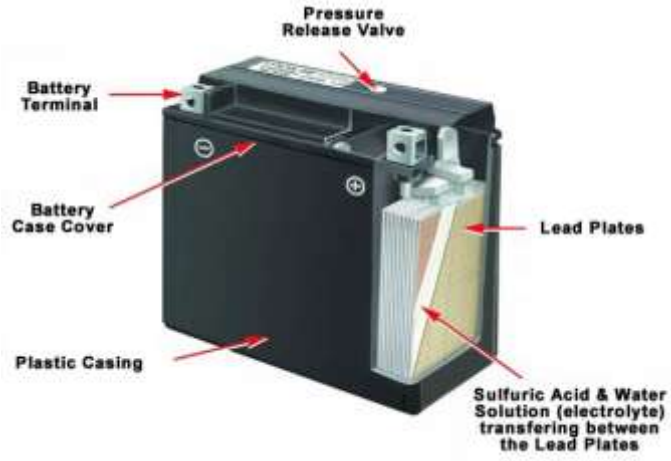
Ignition



What's your part during the activity?

- When you are given a key by the driver, <u>wave the green flag</u> to send a signal to the battery.
- <u>Remind the battery to send electricity</u> to the starter motor, distributor, and fuel pump.

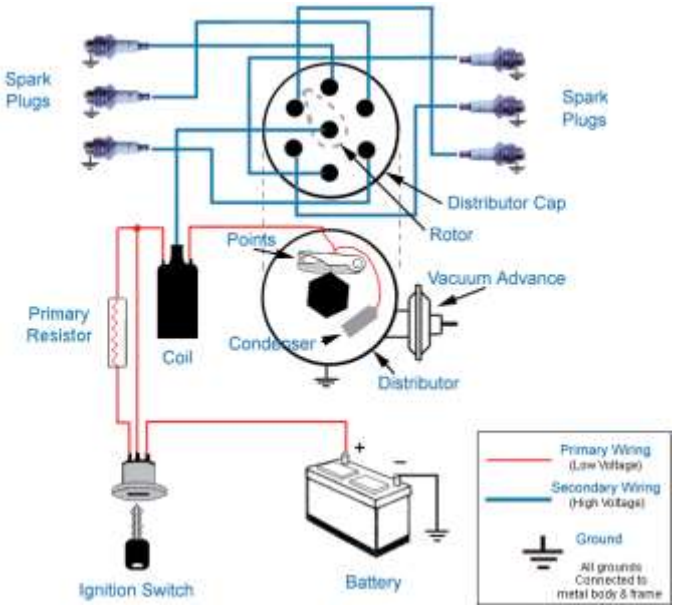
Battery



What's your part during the activity?

- Watch for the signal from the ignition. When you see a green flag being waved, begin to send out the electricity to the rest of the engine. Electricity is represented by streamers.
- Lay one streamer on the floor to connect the battery to the fuel pump.
- Place another streamer on the floor to connect the battery to the starter motor.
- Lastly, place a streamer on the floor to connect the battery to the distributor.

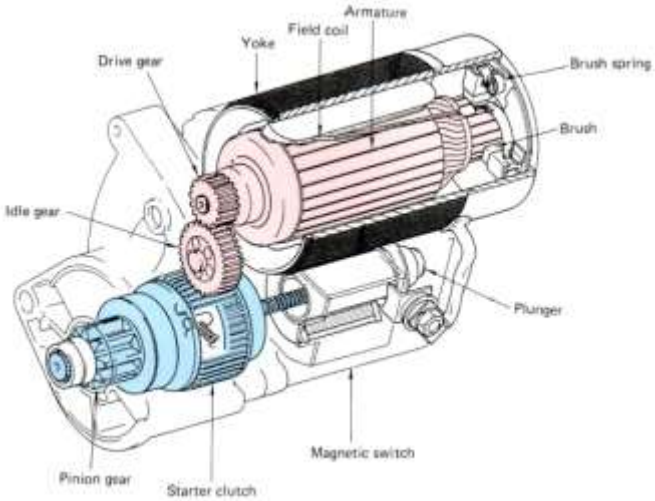
Distributor



What's your part during the activity?

- Watch for a streamer to be laid on the floor to connect you to the battery. The streamer represents electricity. Once you receive electricity from the battery, you are able to send electricity to a spark plug.
- When you hear the timing belt say "power", gently wave a streamer near each spark plug.

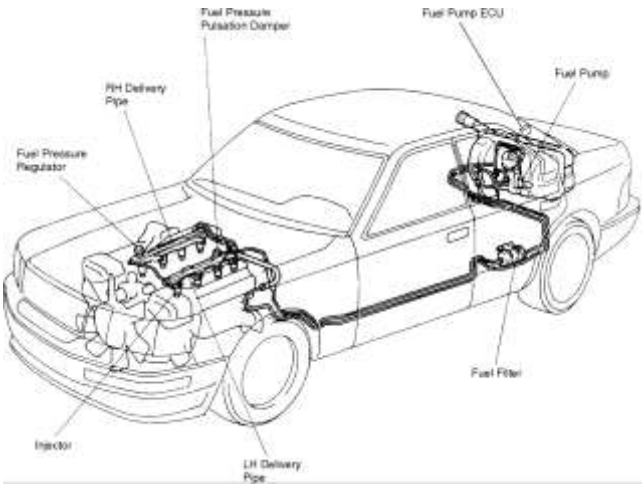
Starter Motor

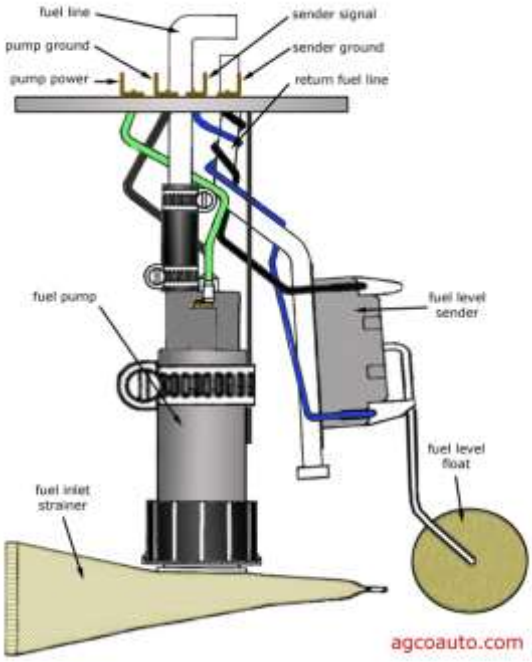


What's your part during the activity?

- Watch for a streamer to be laid on the floor to connect you to the battery. The streamer represents electricity.
- Once you receive electricity from the battery, make the vroom sound of a starting engine.
- Next, send power to the crankshaft by laying a streamer on the floor to connect you to the crankshaft.

Fuel Pump

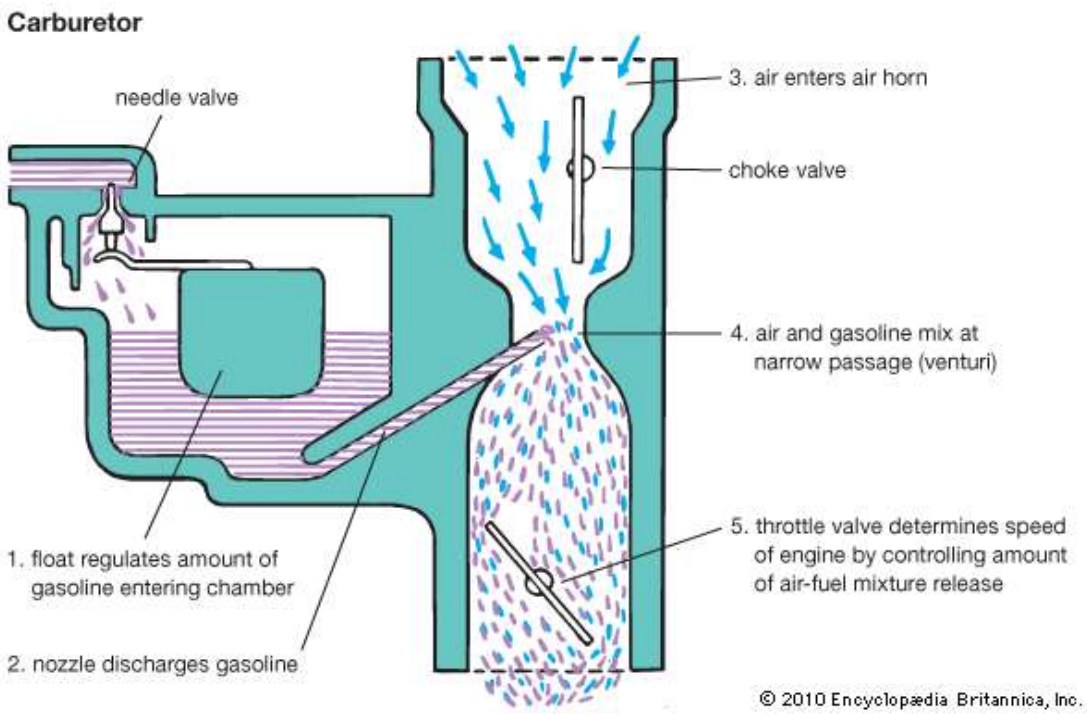




What's your part during the activity?

- Watch for a streamer to be laid on the floor to connect you to the battery. Once you receive this energy, you can begin to pull pump gas from the gas tank.
- The gas tank is represented by a pail and gas is represented by black and brown craft pom poms. Hand one pom pom to the carburetor for each piston in this activity. The carburetor will remind you when it needs more gas.

Carburetor



What's your part during the activity?

- Your job is to send a combination of air and gas to the pistons. Air is represented by white craft pom poms and gas is represented by black and brown craft pom poms.
- <u>Hand each piston one white craft pom pom from the air filter and one black/brown pom pom from the fuel pump. Repeat every time the timing belt says "intake."</u>

Crankshaft

What's your part during the activity?

- You will turn 180 degrees every time to hear and see the following:

What you will hear:	**What you will see:**	**Which direction to face:**
The starting motor will make a "vroom" sound and the timing belt will say "intake."	The pistons will squat and receive an air and gas particle from the carburetor.	Face the starting motor.
The timing belt will say "compression."	The pistons will stand up.	Face the timing belt.
The timing belt will say "power."	The spark plug will lightly touch the piston's air and gas particles with their spark. The pistons will squat.	Face the starting motor.
The timing belt will say "exhaust."	The pistons will stand up and drop their air and gas particles in the exhaust pail.	Face the timing belt.

Air Filter

What's your part during the activity?

- Your job is to separate the clean air particles from the dirty air particles. Clean air particles are represented by white craft pom poms. Dirty air particles are represented by brown, yellow, and gray craft pom poms.
- <u>Hand one white pom pom to the carburetor for each piston in this activity.</u> The carburetor will remind you when it needs more air.

Timing Belt

What's your part during the activity?

- Your job is very important. It is similar to that of a conductor in an orchestra. As you announce each step of the four-stroke cycle, make sure that the other parts of the engine are doing their part.

What you say:	**What the piston does:**	**What the spark plug does:**	**What the crankshaft does:**	**What the carburetor does:**	**What the distributor does:**
1. Intake	The pistons will squat and receive an air and gas particle from the carburetor.		The crankshaft turns to face the starting motor.	The carburetor will hand each piston an air and gas particle.	
2. Compression	The pistons stand up.		The crankshaft turns to face the timing belt.		
3. Power	The pistons squat after the air and gas particles have been gently touched by the spark plug's red pom pom.	The spark plug gently shakes a red pom pom to touch the air and gas particles in the piston's hands.	The crankshaft turns to face the starting motor.		The distributor gently waves a streamer near each spark plug.
4. Exhaust	The pistons stand up and drop their air and gas particles in the exhaust pail.		The crankshaft turns to face the timing belt.		

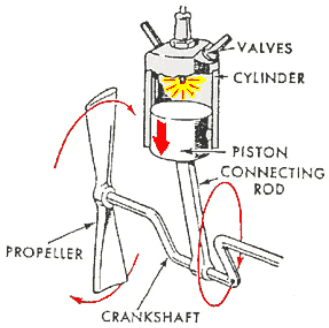
Spark Plug

What's your part during the activity?

- Listen for the timing belt to say "power" and watch for the distributor to gently wave a streamer in your direction. The streamer represents power that will give you the energy to make a spark. Your red pom pom represents a spark.
- Once the distributor gives you power, gently shake the red pom pom to touch the gas and air particles in the piston's hands. The spark you make creates heat that ignites the mixture of gas and air in piston across from you.

Piston

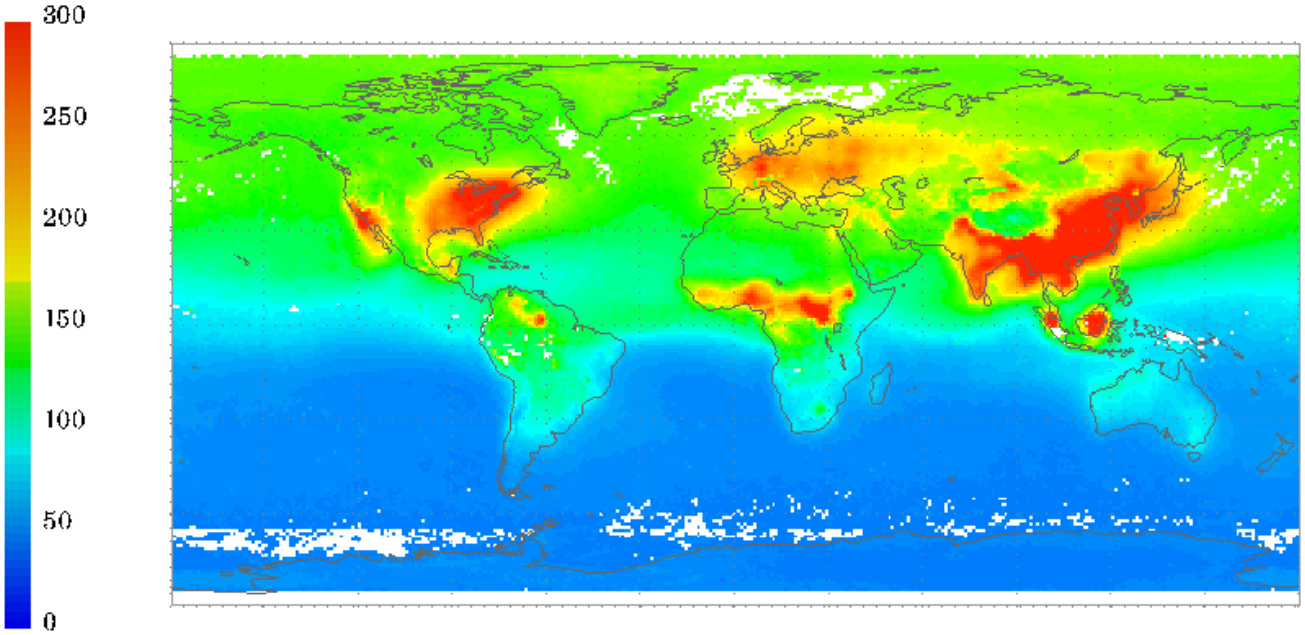
What's your part during the activity?



- Imagine that you are inside of a cylinder and you have a rod that is connected to the crankshaft. When you squat that represents going up and down inside your cylinder, which causes the crankshaft to turn. If a driver pushed on the gas pedal, this process would speed up.

When the timing belt says:	**You do the following:**
1. Intake	Squat and put out your hands so that the carburetor can hand you an air and gas particle. Air and gas particles are represented by craft pom poms.
2. Compression	Stand up and hold the gas and air particles tightly in your hands.
3. Power	Squat after the air and gas particles in your hands have been gently touched by the spark plug's red pom pom. This represents a controlled explosion that forces you to go down inside your cylinder.
4. Exhaust	Stand back up and drop the air and gas particles in the exhaust pail. This represents the burned gases being released.

Carbon Dioxide Collection in the Atmosphere



MOPITT CO Mixing Ratio at Surface (ppbv)

http://en.wikipedia.org/wiki/Motor_vehicle_emissions

http://en.wikipedia.org/wiki/File:SmogNY.jpg

Family Card Options for Fuel Comparison Simulation

Family Name and size:

Smith- single male, twenties
Johnson- single female, thirties
Williams- widowed male, sixties
Miller- single father with one child
Jones- single mother with two children
Anderson – married couple with one child
Wilson- married couple with two children
Taylor – married couple with three children
Martinez- married couple with four children
Martin –married couple with 2 grown children and 4 grandchildren (who visit frequently and carpool in the same vehicle)

Location:

Tacoma, Washington
Los Angeles, California
Anchorage, Alaska
Omaha, Nebraska
Honolulu, Hawaii
New York City, New York
Tampa, Florida
Houston, Texas
Detroit, Michigan
Charlotte, North Carolina

Profession and salary of primary wage-earner:

Homemaker- $0
Unemployed - $0
Retail salesperson- $25,000
Administrative Assistant - $30,000
Construction worker - $35,000
Teacher - $40,000
Social Worker- $45,000
Accountant - $50,000
Librarian- $55,000
Nurse - $60,000
Fashion Designer- $75,000
Investment Banker - $80,000
Lawyer - $100,000
Software Engineer- $125,000
Dentist- $150,000

Commute distance

Drives 5 miles daily during weekdays
Drives 10 miles daily during weekdays
Drives 20 mile daily during weekdays
Drives 30 miles daily during weekdays
Drives 40 miles daily during weekdays
Drives 50 miles daily during weekdays
Drives 60 miles daily during weekdays
Drives 70 miles daily during weekdays
Drives 80 miles daily during weekdays
Drives 90 miles daily during weekdays

Factors that may influence vehicle choice:

Looking for a vehicle can fit one large dog
Looking for a vehicle that can fit two medium-sized dogs
Looking for a vehicle that can be used with a cargo carrier on top for camping equipment
Looking for a vehicle with four-wheel drive
Looking for a vehicle with fast acceleration
Looking for a vehicle that is best to hold luggage for long road trips
Looking for a vehicle that has the least hurtful impact on the environment
Looking for a vehicle that has a convertible top or sunroof
Looking for a vehicle that can carry large loads of plants and equipment for garden
Looking for a vehicle that can haul a boat or trailer

Power Source Comparison Simulation

Name(s):_____ Date:_____

Part I: Family Card Summary

Family Name: _____ # of people in family: _____
Residential Location: _____ Income: _____
Commute Distance: _____Other factors that may influence car choice:
_____

In your small group, discuss which type of car is the best choice for your hypothetical family. Choose one or more of the options below:

- 2-door Small or compact
- 4-door Mid-sized sedan or hatchback
- Station wagon
- Luxury
- Sports
- Minivan/van
- Pickup truck
- Sport utility vehicle.

Explain your preferred choice of vehicle.
_____
_____
_____

Part II: Which type of power source do you CARE to use?

During the station rotations, complete the "CARE" table on the back of this sheet of paper. When finished, discuss with your group which type of power source is best for your hypothetical family. Choose one or more of the options below:

- Petroleum (including gasoline and petroleum-derived diesel)
- Biofuel (including ethanol and biodiesel)
- Electricity
- Hydrogen
- Natural gas or Propane

Explain your preferred choice of power source(s):
_____
_____
_____
_____

*Be aware that many cars are able to combine multiple types of power sources. For example:

- Hybrid cars combine the power of electric motors with petroleum-powered internal combustion engines.
- Standard gasoline contain up to 15% ethanol (a biofuel). Flex-Fuel Vehicles (FFV) are designed to run on gasoline or a blend containing up to 85% ethanol (E85).
- Biodiesel is meant to be used in standard diesel engines. It can be used alone, or mixed at any ratio with diesel.

"Which type of power source do you CARE to use?" Table

Complete the table below while you rotate from one station to another. For each column, rate each fuel type on a scale where 4 is the best and 1 is the worst. Then, compute a final total for each row and write your final thoughts on whether or not it is the best power source for your hypothetical family.

	Convenience How easy is it to refuel? Are refueling stations located close to your hypothetical family's location?	**Affordability** How much does a vehicle using this power source cost? How expensive is it to refuel or recharge in your hypothetical family's location?	**Reliability** Will this power source work well in your hypothetical family's location? Is this power source commonly available for the type(s) of vehicle(s) that your hypothetical family prefers?	**Environmental Effects** What are the potentially harmful effects of extracting this power and using it propel vehicles?	**Total Score and Final Thoughts**
Petroleum*	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	
Biofuel**	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	
Electricity***	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	
Hydrogen	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	
Natural Gas and Propane	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	4 3 2 1 Why?	

*Petroleum products include standard gasoline and petroleum-derived diesel.

**Biofuel products include ethanol (made from plant sugars, mainly corn) and biodiesel (made from recycled vegetable oil or animal fats).

***The energy stored in electric car batteries may be generated by using power from the following energy sources: coal, natural gas, nuclear, hydroelectric, renewable sources (such as wind or solar), and petroleum.

1899 Baldwin Steamer	
1912 Standard Electric	
1918 Cadillac Type 57	

1919 Stanley Steamer	
1925 Ford Model T Roadster Pickup Truck	
1930 Duesenberg Model J	

1937 Fiat Topolino	
1953 Citroen 2CV	
1963 Chevrolet Corvette Sting Ray	

1983 DeLorean DMC 12	
1989 Buick Regal Chattanooga Chew	
2005 Momentum	

2009 Dodge Charger #9 Budweiser	
2012 No. 5 Farmers Insurance Chevrolet	
2012 Toyota Prius