Lesson Plan

This lesson plan is intended to give students an opportunity to explore the different types and forms of energy, how they are transferred, and how they help work to be done; through the lens of the combustion engine. Inside a combustion engine, energy takes the form of chemical, potential, kinetic, mechanical and thermal, all to create work by making a car move. Students should complete this lesson plan with a better understanding of not only of how to identify the various types of energies and how they transfer, but also how a combustion engine functions. The IMS Museum seeks to help classrooms make real-world connections with our collections by encouraging students and teachers to learn about all aspects of racing.

This lesson plan is intended to be used in addition to others on the subject.

Essential Questions

- What is energy?
- What are the different types of energy?
- How is energy transferred?
- What is work?
- How does energy make a car move?

Objectives

- Understanding of how energy and energy transfer occur in a real-world example of the car
- Ability to identify the different types of energy and energy transfer
- Understanding of how a combustion engine functions and powers a car

Instructions

1. Read over materials provided
2. Conduct further research if necessary
3. Present materials and information to class
4. Guide through activities

Time Needed

- 1-3 class periods
- 30 minutes to present materials
- 15 minutes for quiz
- 10 minutes to go over quiz with answer key
- 30-45 minutes for cylinder assembly (could also be take home project)
- 30 minutes for descriptive essay

Activity

1. Complete the quiz on energy types and transfers
2. Using the sheet provided – each student will cut out and assemble the combustion chamber and label the energy processes occurring inside
3. Using the assembled combustion chamber – each student should write a short descriptive essay on what processes are occurring at the different stages of a four-stroke engine.

Age/Grade Level
Ideal age/grade level for projects ranging 4th – 6th grade

Assessment
Evaluation of quiz and final projects
Discussion: Ask students the following questions
1. What is energy? (answers could include “the ability to do work” or “to do work, energy is needed”)
2. How can we describe an engine using energy terms? (answers could include “An engine uses chemical energy from fuel to cause a thermal and mechanical energy transfer that makes the wheels move”)

Overview/Background
In the simplest of ways, a car is an energy converter; it is a machine that releases the chemical energy contained in gasoline and converts it into mechanical energy in the moving wheels. When the wheels are moving the car, the mechanical energy is changed to kinetic energy, possessed by the car and occupants inside and they travel. A car’s engine (the combustion engine), is built around several main components called cylinders (also known as combustion chambers) these act like cooking pots for the fuel. Cylinders are like bicycle pumps in the way they function with one end sealed with a tightly fit plunger, called a piston. In many cars there are at least four cylinders in the engine, converting energy to work.

Inside each cylinder there are reactions and processes happening which coincide to different energy forms and transfers. The complexity of the entire automobile engine can be simplified down to a simple chemical reaction that creates mechanical work through intake and compression.

Content Standards
Physical Science
4.PS.1 – Investigate transportation systems and devices that operate on or in land...
4.PS.2 and .4 – Describe and investigate the different ways in which energy can be generated and/or converted from one form of energy to another
4.PS.5 – Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents
6.PS.3 – Describe how potential and kinetic energy can be transferred from one form to another

Science and engineering process standards
SEPS.2 – Developing models and tools
SEPS.3 – Constructing and performing investigations
SEPS.4 – Analyzing and interpreting data
SEPS.8 – Obtaining, evaluating, and communicating information

Literacy
Writing routinely

6-8.LST.4.1 – Reading: integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually.

Resources

Youtube:

https://www.youtube.com/watch?v=DKF5dKo_r_Y

https://www.youtube.com/watch?v=Q0LBegPWzrg

The Offenhouser parts petting zoo, located at the IMS Museum

Materials

- Energy type quiz and answer key
- Combustion chamber assembly sheet
- Combustion chamber worksheet
- Combustion chamber activity grading rubric
- For in-class combustion chamber assembly – scissors, glue sticks, different colored pencils/crayons, etc. and base sheet

Teacher Resources

Basic energy concepts:

- Energy is the ability to do work or cause change.
- Energy cannot be created or destroyed; it can only be changed into different forms
- Energy can be classified in two ways:
  1. Potential Energy – which is the amount of energy “stored” in every object
  2. Kinetic Energy – Which is the energy of any object in motion
- Work occurs when a force acts on an object to move it to some distance
- Force puts an object into motion, or stops an object if it is already moving
- Motion is a change in position of an object

Forms of Energy

Mechanical: It results from the mix of kinetic and potential energy. The force that acts on an object to make it change shape, move, or displace from its original location.
Chemical: The stored energy in the bonds of chemical compounds.

Thermal: “Heat energy”; Determined by the activeness of atoms or molecules in an object. It is the energy that comes from the temperature of a material or object.

Electrical: Caused by the movement of electrons

Light: the kinetic energy carried in electromagnetic radiation

*note – there are other forms of energy; however, this lesson is focused on the energy forms above

**How an engine works**

Car engines are built around a set of cylinders, inside which the fuel burns. The cylinders are metal and have tight fitting plungers, or pistons, inside them that slide up and down. At the top of each cylinder are two valves. The intake valve allows fuel and air into the cylinder from the carburetor or fuel-injector. The exhaust valve lets the waste gases out of the cylinder. A sparkplug is at the top of the cylinder and sets fire to the fuel/air mixture. At the bottom of the cylinder, the piston is attached to a constantly turning axle called the **crankshaft**. The crankshaft powers a vehicle’s gearbox, which, in turn powers the car and makes it move.
Four-Stroke Engine

1. Intake – The piston is pulled down the cylinder which opens the intake valve, letting in air and fuel.
2. Compression – The intake valve closes, and the piston moves back up the cylinder and compresses the fuel-air mixture. This compression makes the mixture much more flammable.
3. Power – When the piston reaches the top of the cylinder, the spark plug fires and ignites the fuel-air mixture. The mini explosion from the combusting fuel creates heat and gas, pushing the piston down the cylinder. The energy has been released from the fuel, powering the crankshaft.
4. Exhaust – The exhaust valve opens as the piston moves back up the cylinder, pushing the waste gases out of the cylinder.

The whole cycle then repeats itself

How many cylinders are needed in an engine?

Typically, a vehicle will have a minimum of four cylinders. Because of the process of a four-stroke engine, the crankshaft is only being powered during one stage out of the four. A vehicle needs multiple cylinders to ensure that the crankshaft is properly powered at all stages, cylinders are timed so that there is at least one cylinder at every stage of the four-stroke engine process.
ANSWER KEY

Label each example with the form of energy

1. Yo-yo held in your hand ________POTENTIAL________ energy
2. Yo-yo in motion ______________KINETIC________ energy
3. Apple on a tree __________________POTENTIAL____ energy
4. Apple falling from a tree ____________KINETIC____ energy
5. Stretching a rubber band ___________POTENTIAL____ energy
6. A battery ___________________CHEMICAL________ energy
7. Rubbing your hands together ________THERMAL____ energy
8. Melting ice cream ____________THERMAL________ energy
9. Hammering a nail ______________MECHANICAL________ energy
10. Ball rolling down a hill ____________KINETIC____ energy

Use the word bank below to help label the diagrams of energy transfer

WORD BANK

KINETIC POTENTIAL ELECTRICAL
CHEMICAL THERMAL
MECHANICAL LIGHT
Energy Types Quiz

Name ________________________________ Date ______________________

Label each example with the form of energy

1. Yo-yo held in your hand ________________ energy
2. Yo-yo in motion _______________________ energy
3. Apple on a tree _________________________ energy
4. Apple falling from a tree ________________ energy
5. Stretching a rubber band ________________ energy
6. A battery _____________________________ energy
7. Rubbing your hands together _____________ energy
8. Melting ice cream ______________________ energy
9. Hammering a nail ______________________ energy
10. Ball rolling down a hill __________________ energy

Use the word bank below to help label the diagrams of energy transfer

WORD BANK

KINETIC POTENTIAL ELECTRICAL
CHEMICAL THERMAL MECHANICAL LIGHT
Assemble and label the combustion chamber:

Combustion Chamber
Exhaust
Intake
Sparkplug
Crankshaft
Piston
assembly suggestion
Combustion Engine

Name ____________________  Date __________________

A combustion engine is an example of an energy converter. An engine uses the energy stored in fuel and converts it to work, which powers a vehicle. Using the pieces from the combustion chamber handout, assemble correctly a combustion chamber, and label the various energy types and what happens in the chamber to create work.

There are two tubes that lead into and out of the combustion chamber. One brings fuel into the chamber and one takes exhaust, or waste, out. Place both tubes and the fuel can at the correct positions with the combustion chamber.

The spark plug is placed at the top of the combustion chamber. Place the Spark plug and label what type of energy is used to power the spark, which ignites fuel inside the combustion chamber.

Fuel comes into the combustion chamber and mixes with oxygen. When the fuel and oxygen are ignited by the spark plug there is a reaction which creates what type of energy?

_________________________

This energy moves the piston, which is tightly fit inside the combustion chamber. The piston is connected to the crankshaft with a connecting rod. What direction does the piston move in?

_________________________

As the piston moves and in turn moves the crankshaft this powers the wheels of the car. What type of energy is being used when the crankshaft moves?

_________________________

Once all the pieces of the combustion chamber are assembled, make sure to label the different types of energy, including kinetic and potential energy.

Explain how a combustion engine works, using the different types of energy that are in the process

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## Combustion Chamber Grading Rubric

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**Additional Notes:**