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Piezo Popper Kit

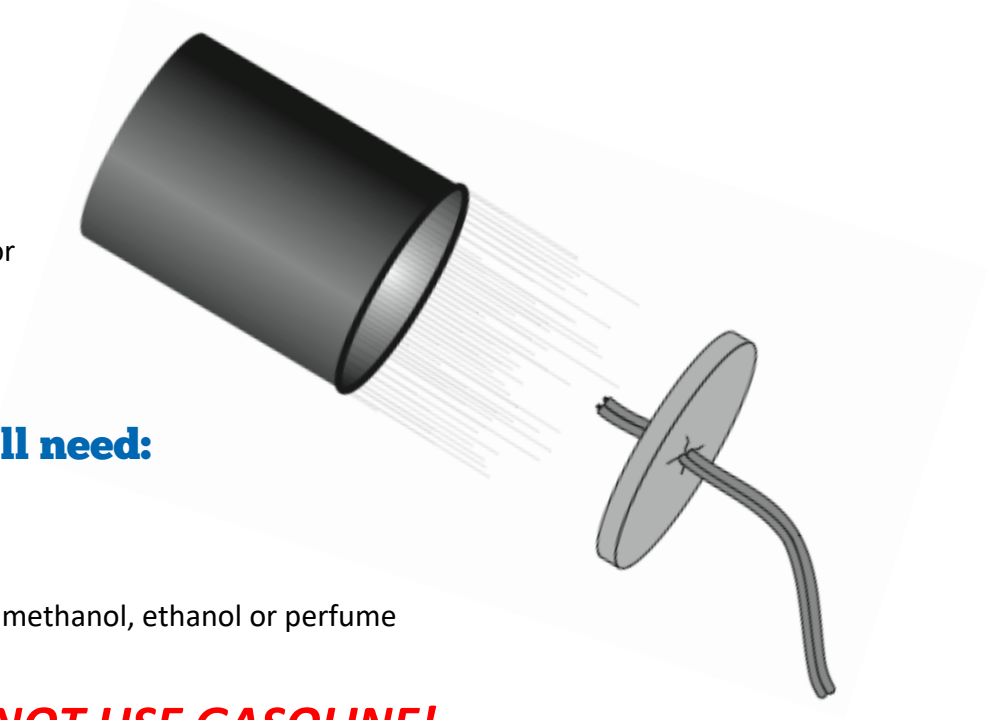
HS-2A

A Film Canister Explosion

A film canister attached to a piezoelectric igniter can be used to demonstrate the energy contained in two drops of a flammable liquid. Upon ignition, the film canister travels several feet.

Your kit includes:

- ✓ 1 Piezoelectric igniter
- ✓ 1 lamp cord assembly with metal butt connector
- ✓ 1 plastic film canister



Other materials you'll need:

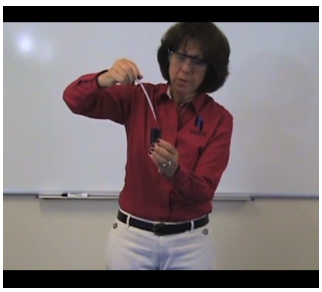
- ✓ pair of pliers
- ✓ electrical tape
- ✓ flammable liquid such as methanol, ethanol or perfume

DO NOT USE GASOLINE!

Preview the Piezo Popper in action:

If you'd like to review a video of the Piezo Popper in action, check out our YouTube channel:





https://www.youtube.com/watch?v=ZKdTXMxF8nU

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NGSS Correlations

Our Piezo Popper Kit and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

K-ESS1-4
Students can make observations of a demonstration of the Piezo Popper Kit to understand local weather conditions (thunder and lightning). Students can use and share observations of local weather conditions to describe patterns over time.

3-PS2-2
Students can use the Piezo Popper Kit in an investigation to make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

4-PS3-2
Students can use the Piezo Popper Kit in an investigation to make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-3
Students can use the Piezo Popper Kit in an investigation to ask questions and predict outcomes about the changes in energy that occur when objects collide.

Middle School

MS-PS1-4
Students can use the Piezo Popper Kit to develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS1-6
Students can use the Piezo Popper Kit to design a project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

MS-PS2-2
Students can use the Piezo Popper Kit in an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS3-3
Students can use the Piezo Popper Kit in an investigation to apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

DCI-MS/PS1.B: Chemical Reactions.
Some chemical reactions release energy, others store energy.

DCI-MS/ETS1.B: Developing Possible Solutions.
A solution needs to be tested, and then modified based on the test results in order to improve it.

High School

HS-PS1-3
Students can use the Piezo Popper Kit in an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4
Students can use the Piezo Popper Kit to develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5
Students can use the Piezo Popper Kit in an investigation as evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which the reaction occurs.

HS-PS2-6
Students can use the Piezo Popper Kit to make observations and communicate scientific information about why the molecular-level structure is important in the functioning of a material.

DCI-HS/PS1.B: Chemical Reactions.
Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the

NGSS Correlations

continued

DCI-4/PS1.B: Conservation of Energy and Energy Transfer.
Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, typically also transferred to the surrounding air; as a result, the air gets heated and sound produced.

collisions of the molecules and the rearrangements of the atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that ate matched by changes in kinetic energy.

DCI-HS/PS2.B: Types of Interactions.
Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, a transformation of matter, as well as the contact forces between material objects.

Suggested Science Idea(s)

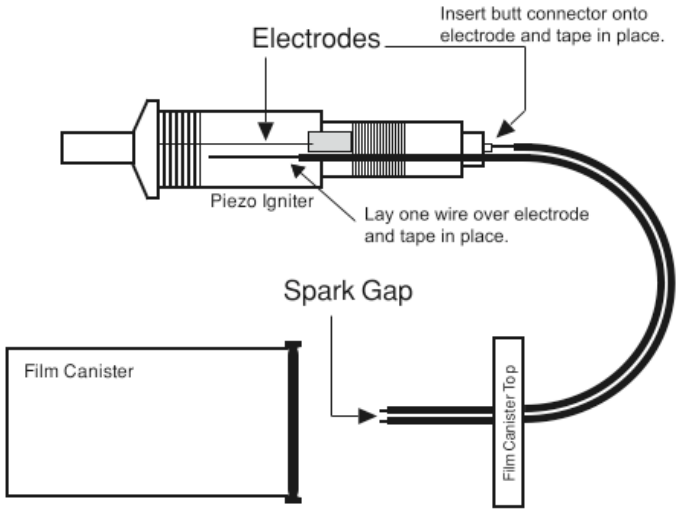
K-ESS1-4
Students can make observations of a demonstration of the Piezo Popper Kit to understand local weather conditions (thunder and lightning). The heating and release of energy, is a tangible simulation of what happens during a thunder and lightning storm.

3-PS2-2 • 4-PS3-2 • 4-PS3-3 • DCI-4/PS1.B
For younger children a demonstration of the Piezo Popper provides a very visual, loud and active display of physics. Students can use the experience to understand energy, energy transfer, motion, weather and chemical reactions

MS-PS1-4 • MS-PS1-6 • MS-PS2-2 • DCI-MS/PS1.B • DCI-MS/ETS1.B • HS-PS1-3 • HS-PS1-4 • HS-PS1-5 • HS-PS2-6 • DCI-HS-PS1.B • DCI-HS-PS2.B
Students can use the Piezo Popper in a number of different investigations that involve combustion. It is safe for the mature students to manipulate and operate. D uring the operation of the Piezo Popper, safety goggles must be worn and supervision from the teacher maintained. Students add **two drops only** of a flammable liquid, e.g. ethanol, methanol, acetone, or perfume to the film canister. (Do not use gasoline.) Cover with the cap, shake, and warm the canister in your hands. Warn students that it makes a loud noise, and that they should cover their ears. Point it away from people and push the red button of the charger. The film canister could travel over ten feet! Students can learn about and build on their knowledge of chemical reactions, energy, energy transfer, weather, electric currents, and motion.

Using Your Piezo Popper

Preparing your Piezo Popper:



1. Push and twist the "butt connector" on the wire assembly onto the electrode end of the igniter. Note: you may need pliers to twist this connector into place. Tape the adjacent, long exposed bare wire against the long outside wire of the igniter. Use electrical tape to completely cover the bare wires. Starting with the end near the button of the piezoelectric igniter, completely wrap the exposed bare wires with electrical tape. As an option, use heat shrink tubing over the electrical wires to make for a nice, neat looking apparatus.

2. Punch a hole in the soft plastic cap of a film canister with a ballpoint pen. Insert the other end of lamp cord through the top of the film canister as shown above. The spark gap should be on the inside of the film canister. Do not remove any of the wire insulation, but separate the two strands slightly, ≈ 5mm, to insure a proper spark gap.

3. Test by pushing the button of the piezoelectric igniter. If it is properly assembled, you should see a spark jump a distance of almost a centimeter.

Using your Piezo Popper:

Use appropriate safety precautions.
Eye protection is recommended.

1. Add NO MORE THAN two drops of a flammable liquid, e.g. ethanol, methanol, acetone, or perfume to the film canister. **(Do not use gasoline.)** Cap, shake, and warm the canister in your hands. **Warning: to avoid a flaming missile, do not use more than two drops.**

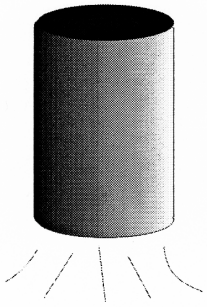
2. Warn people that it makes a loud noise, and that they should cover their ears.

3. Point it away from people and push in the button. The film canister could travel over ten feet!

Acknowledgement: "Micro Explosions" by Al Definer, The Chemistry Teachers' Club of New York, 1/93

Determine the Efficiency of a Film Canister Engine

By Ron Perkins (retired, Greenwich H.S., Greenwich, CT)

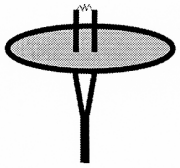


Two drops of methanol are placed in a film canister and ignited with a high voltage spark. The film canister travels several meters into the air. Determine the efficiency of this simple engine.

Step #1 Collect Data

Data Table

Mass of Canister (without lid)	kg
Height Traveled by Canister	meters
Acceleration of gravity	9.8 meters/sec^2



Step #2 Calculate the Energy Used to Move the Film Canister

How much energy is transferred to the film canister from the combustion of two drops of methanol?

PE = m g h

PE = (kg) (9.8 meters/sec^2) (meters)

PE = _____ joules

The maximum amount of energy available for useful work when two drops of methanol are ignited is about 747 joules. This is called the free energy and can be determined from thermodynamic tables. The efficiency of an engine is based on how close it comes to this value. The number given here assumes that the alcohol burns totally to produce carbon dioxide and water vapor.

$$CH_3OH_{(g)} + 3/2\ O_{2(g)} \rightarrow 1\ CO_{2(g)} + 2\ H_2O_{(g)}$$

Step #3 Calculate the Efficiency of the Engine

% Efficiency of Engine = (Energy Used / Max Energy Available) (100)

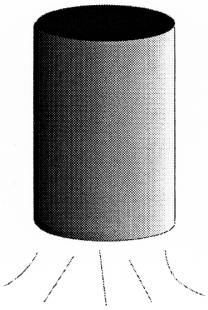
= (? / 747 joules) x 100

= ____ %

Note: An automobile is about 20% efficient. Are you surprised that your value is so different?

Advanced Version
Determine the Efficiency of a Film Canister Engine

By Ron Perkins (retired, Greenwich H.S., Greenwich, CT)



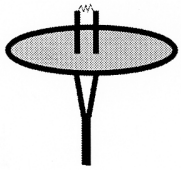
Two drops of methanol are placed in a film canister and ignited with a high voltage spark. The film canister travels several meters into the air. Determine the efficiency of this simple engine.

Step #1 Collect Data

Data Table

Mass of Canister (without lid)	kg
Height Traveled by Canister	meters
Acceleration of gravity	9.8 meters/sec^2
Mass of 100 Drops of Methanol	g

Step #2 Calculate the Energy Used to Move the Film Canister



How much mechanical energy is transferred to the film canister from the combustion of two drops of methanol?

$PE = m\ g\ h$

PE = (kg) (9.8 meters/sec^2) (meters)

PE = ? Joules

Step #3 Calculate the Free Energy Available from Burning One Mole of Methanol

The maximum amount of energy available for useful work by the combustion of one mole of methanol is called its free energy, ΔG_{rx}^{o}. It can be determined from thermodynamic tables. The efficiency of an engine is based on how close it comes to this value. $CH_3OH_{(g)} + 3/2\ O_{2\,(g)} \rightarrow 1\ CO_{2\,(g)} + 2\ H_2O_{(g)}$

Table of Gibbs Free Energies (kJ/mol)

	$CH_3OH_{(g}$	$O_{2\,(g)}$	$CO_{2\,(g)}$	$H_2O_{(g)}$
ΔG_f^{o} (KJ/mol)	-163	0	-394	-229

$$\Delta G_{Rx}^{o} = \Sigma\ \Delta G_f^{o}{}_{Products} - \Sigma\ \Delta G_f^{o}{}_{Reactants}$$

ΔG_{Rx}^{o} = ? kJ / mol

Step #4 Calculate the Free Energy Available from Burning Two Drops of Methanol

Step #5 Calculate the Efficiency of the Engine

% Efficiency of Engine = [(Energy Used to Move Canister / Free Energy per 2 Drops of Fuel)] (100)

= %

Note: An automobile is about 20% efficient. Are you surprised that your value is so different?

Take Your Lesson Further

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http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

Handboiler (HB-100)

Great vapor pressure demonstration! When the handboiler is held in your hand, liquid quickly travels from the bottom bulb to the top along with numerous bubbles, giving the appearance of boiling. These new and improved hand-boilers are from a thicker glass and less likely to break.

Mighty Seltzer Rocket (RKT-555)

This cleverly designed rocket with nose cone and fins will travel 20 to 30 feet into the air. Simply pour in water, drop in a seltzer tablet, replace the end cap, and the rocket is prepared for launch. To activate, simply invert the rocket, place it on a flat surface and move away. Adult supervision and eye protection required. Not for indoor use. Four seltzer tablets included with single rocket.

Fire Syringe Demo (FIR-150)

When the plunger in the transparent cylinder is rapidly pushed down over a piece of cotton or paper towel, ignition occurs. This is one of the most impressive demonstrations of the heat produced when a gas is rapidly compressed - the principle of the Diesel engine ignition. Safety Glasses required. Approximately 22 cm tall (~8.5"). (Not appropriate for elementary schools.)