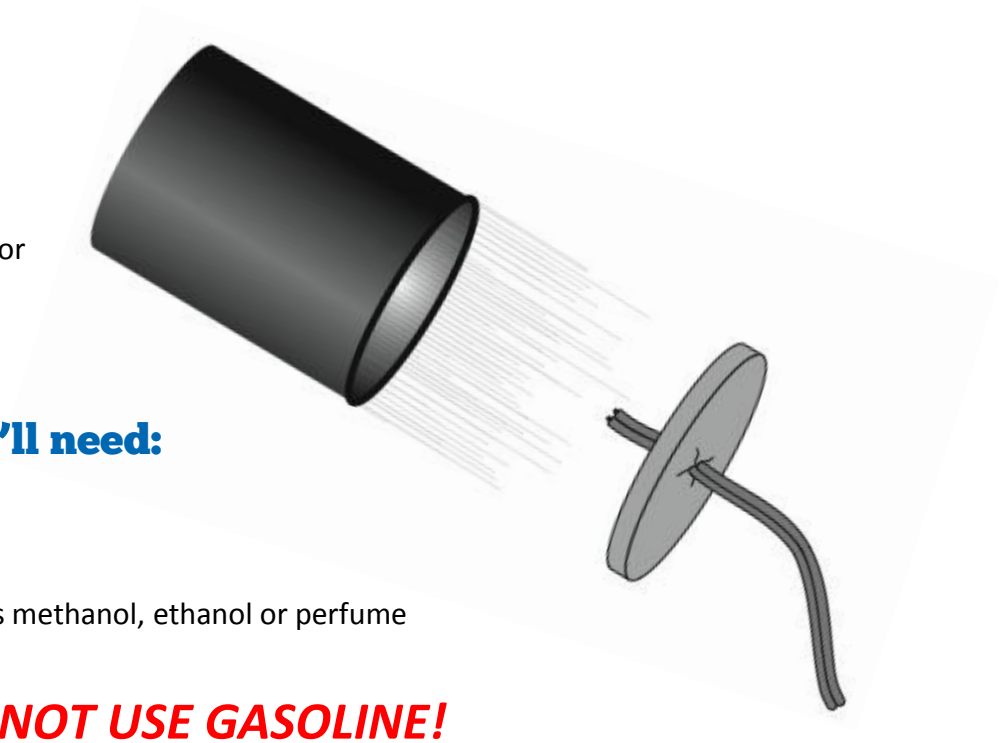
Piezo Popper Kit

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:

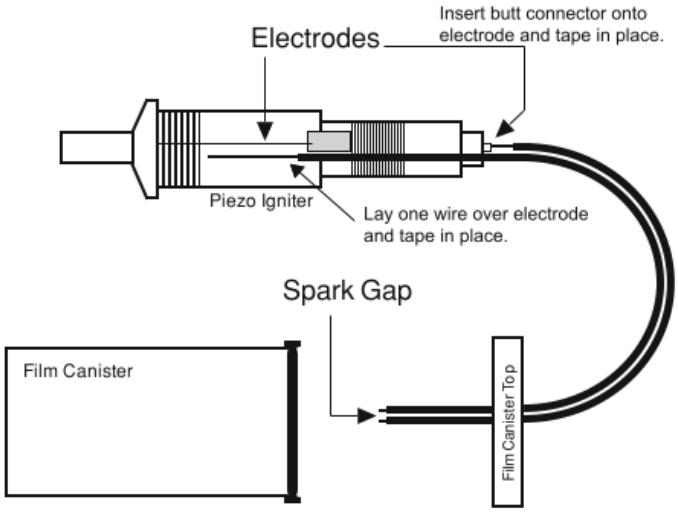
https://www.youtube.com/watch?v=ZKdTXMxF8nU

5 Francis J. Clarke Circle
Bethel, CT 06801

Phone (203) 74-TEACH (83224)
Fax (203) 229-0740
www.TeacherSource.com

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.**

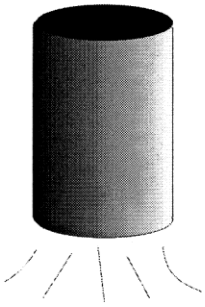
2. Warn people that it makes a loud noise, and that they should cover their ears.

3. Point it away from people and push in the button. The film canister could travels 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)

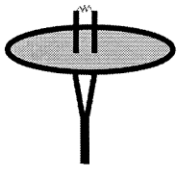


Two drops of methanol are placed in a film canister and ignited with a high voltage spark. The film canister travels several meters into the air. Determine the efficiency of this simple engine.

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)

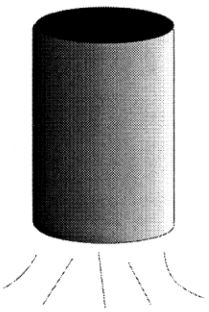
= (? / 747 joules) x 100

= ____ %

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)



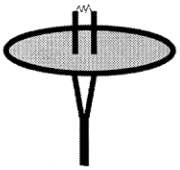
Two drops of methanol are placed in a film canister and ignited with a high voltage spark. The film canister travels several meters into the air. Determine the efficiency of this simple engine.

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}°. 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° (KJ/mol)	-163	0	-394	-229

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

ΔG_{Rx}° = ? 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

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

www.TeacherSource.com

Check our blog for classroom-tested teaching plans on dozens of topics:

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.

Exergia Candle Stirling Engine - Learning Kit (HS-215)

This medium temperature Stirling engine is powered by the heat of a usual tea light candle. It is highly suitable for easy and quick demonstration of the basic thermo-dynamics working in a hot air engine and is great fun to assemble. The kit includes all necessary parts (~150) to assemble the engine and candle rack. Includes assembly drawings and a construction guide (which provides the step-by-step instructions to build) including a paragraph explaining the engine's function.

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.

Gas Solubility Demonstration aka the Baby Bottle Experiment (BOT-815)

An unopened can of soda feels very solid because of the more than 3 volumes of dissolved carbon dioxide gas creating a pressure of about 55 PSI above the liquid. Fill a baby bottle with soda, secure with a rubber nipple without a hole, and shake. Watch the nipple expand as the gas comes out of solution. Amazing to see! Great for teaching Henry's Law of Partial Pressures. Compare different types of soda; soda at two different temperatures; etc. Includes one baby bottle, two rubber nipples without holes, and instructions.