


Piezoelectric Power as an Alternative Energy Source?

Subject Area(s) Physical Science, Science and Technology, Life Sciences

Associated Unit Energy, Alternative Energy Sources, Environments and Ecosystems.

Lesson Title Piezoelectric Power as an Alternative Energy Source?



ADA Description: (Three photos are shown. The one on the left is piezoelectric element. The center photo is a phone charger and the last photo is a cell phone.)

Source/Rights:

Element: <http://uk.farnell.com/multicomp/mcft-27t-4-2al-127/piezo-element/dp/1801061>
iPhone: <http://www.nowhereelse.fr/iphone-6-apple-79866/>
Charger: <http://www.engadget.com/2009/10/23/support-for-universal-micro-usb-phone-chargers-grows-with-itu-ap/>

Caption: Can piezoelectric energy be harnessed and used as an alternative power source?

Grade Level 9-12

Lesson # 1 of 1

Lesson Dependency

Time Required Two or three 50 min class sessions

Summary

Day 1: (1/2 day) Hook and Introduction: Students will see how sparks are produced when you chew on Wintergreen Lifesavers and will learn about how more UFO sightings are reported around the time of earthquakes. Both of these phenomena are caused by the piezoelectric effect.

Day 2: Piezoelectric Demo and Lab: Students will learn about the piezoelectric effect and what causes it. They will build a circuit to demonstrate the effect and will redesign their circuit to improve on its output. They will also evaluate their circuit as a feasible means of alternative energy.

Day 3: Research and Design Presentation: Students will research the ways that the piezoelectric effect is being used in current technology as an alternative energy source. They will also create their own idea for a design.

Engineering Connection

Scientists are continually looking for ways to avoid the over use of fossil fuels.

Engineering Category =

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Piezoelectricity

Keywords

renewable resource, non-renewable resource, conversion, electricity, electromechanical energy, energy capture, energy harvesting, generator, mechanical energy, piezoelectric

Educational STEM Standards (List 2-4)

State STEM Standard (required)

SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.

ITEEA Standard (required)

Standard 5. Students will develop an understanding of the effects of technology on the environment.

G. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling.

H. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important.

J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.

K. Humans devise technologies to reduce the negative consequences of other technologies.

9-12

Standard 11. Students will develop the abilities to apply the design process.

M. Identify the design problem to solve and decide whether or not to address it.

N. Identify criteria and constraints and determine how these will affect the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

Q. Develop and produce a product or system using a design process.

9-12

NGSS Standard (strongly recommended)

SC.912.L.17.11: Evaluate the costs and benefits of renewable and nonrenewable resources, such as water, energy, fossil fuels, wildlife, and forests.

SC.912.P.10.1 Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.

CCSS Standard (strongly recommended)

LAFS.1112.RST.1.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

LAFS.1112.RST.4.10 By the end of grade 12, read and comprehend science/technical texts in the grades 1112 text complexity band independently and proficiently.

Pre-Requisite Knowledge

Learning Objectives

After this lesson, students should be able to understand that various materials have piezoelectric properties. They will also be able describe the process of harvesting energy and will be able to make connections to how this procedure applies to possible alternative energy sources.

Introduction / Motivation (5E – Engage)

In Marine Science II, students learn about many of the problems that are facing our ocean. One of the greatest issues is burning of fossil fuels. As part of our curriculum we explore the possibility of many alternative energy sources. Among these are solar, geothermal, tidal, and nuclear.

This lesson plan opens with a video which shows how crushing wintergreen lifesavers produces a spark. <https://www.youtube.com/watch?v=orpU1CnUyRA>

Followed by an article: <http://www.scientificamerican.com/article/mysterious-light-associated-earthquakes/>

Both of these phenomena are caused by the piezoelectric effect.

Lesson Background & Concepts for Teachers (5E – Explain)

The piezoelectric effect is defined as:

Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. The word Piezoelectric is derived from the Greek piezein, which means to squeeze or press, and piezo, which is Greek for “push”.

Students will be introduced to this effect and they will construct a demo to witness how pressing on a piezoelectric element can light an LED.

Vocabulary / Definitions

Word	Definition
conversion	the process of transforming energy from one form into another.
electricity	the set of physical phenomena associated with the presence and flow of electric charge. Electricity gives a wide variety of well-known effects, such as lightning, static electricity, electromagnetic induction and electric current.
energy harvesting	is a process that captures small amounts of energy that would otherwise be lost as heat, light, sound, vibration or movement.
generator	a device that converts mechanical energy to electrical energy for use in an external circuit.
mechanical energy	the sum of potential energy and kinetic energy. It is the energy associated with the motion and position of an object.
non-renewable resource	A resource of economic value that cannot be readily replaced by natural means on a level equal to its consumption. Most fossil fuels, such as oil, natural gas and coal are considered nonrenewable resources in that their use is not sustainable because their formation takes billions of years.
piezoelectric	the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure.
renewable resource	A renewable resource is a resource which is replaced naturally and can be used again. Examples are: oxygen, fresh water, solar energy, timber, and biomass.

Associated Activities (5E – Explore)

During this section of the lesson, students will create a circuit using the supplies listed below. (Instructions are provided in the accompanying powerpoint “iPiezo”)

The circuit will allow students to collect energy from the piezo element to light an LED. A class competition will be used to have students redesign their circuit to light the LED for the longest period of time

Assessment (5E – Evaluate)

Students are provided with formulas and examples to help them determine if this type of power is a feasible alternative power source. (See accompanying power point “iPiezo” for specific details.

Lesson Extension Activities (5E – Extension)

Students will be challenged to research the ways piezoelectricity is being used as an alternative energy source. Examples and specifics are provided in the accompanying power point. In

addition, students will be asked to develop their own idea for how they would use this effect in a technology of the future.

Additional Multimedia Support

Accompanying Power Point called “iPiezo.” This presentation describes the lesson in detail and contains the video links and the instructions for the lab.

References and Article Suggestions for Students

"Energy Harvesting." *Energy Harvesting*. Institute of Physics, n.d. Web. 30 July 2015.

"Generating Electricity By Walking - Google Science Fair 2014." *YouTube*. YouTube, n.d. Web. 30 July 2015.

"Piezo Systems: History of Piezoelectricity." *Piezo Systems: History of Piezoelectricity*. PIEZO SYSTEMS, INC., n.d. Web. 30 July 2015.

"Piezoelectric+classroom+demo." Mrsciguy, 10 July 2010. Web. 30 July 2015.

"Piezoelectric Generator." *YouTube*. YouTube, n.d. Web. 30 July 2015.

"Piezo Electric Battery Charging Shoe." YouTube. YouTube, n.d. Web. 30 July 2015.

"Power from Walking Piezoelectric Energy." YouTube. YouTube, n.d. Web. 30 July 2015.

"Power Walking." - *STAB Resources*. The Tech Resources, n.d. Web. 30 July 2015.

"SCIENTIFIC EXPERIMENTS AT HOME:." *WintOGreen Lifesavers*. Townson University, n.d. Web. 30 July 2015.

"Some Bay Area Residents Report Mysterious Flashes In The Sky During Napa Quake." *CBS San Francisco*. N.p., n.d. Web. 30 July 2015.

Weise, USATODAY Elizabeth. "Scientists Find Records of Rare 'earthquake Lights'" *USA Today*. Gannett, 02 Jan. 2014. Web. 30 July 2015.

"Why Do Wint-O-Green Life Savers Spark in the Dark?" *HowStuffWorks*. N.p., n.d. Web. 30 July 2015.