
IMH TEP'S

LEGACY ACADEMY

9.8 Making a Shaker (or Forever) Flashlight

Grade 9 Activity Plan

Reviews and Updates

9.8 Making a Shaker (or Forever) Flashlight

Objectives:

1. To apply knowledge of electromagnetic induction to generate power for the flashlight.
2. To be familiar with some basic circuit elements and their functions.
3. To understand how a shaker flashlight works by making one.

Key words/concepts: power, generator, electricity, magnet, coil, charge, AC, DC, rectifier, diode, electromagnetic induction, capacitors, Electromotive force.

Curriculum outcomes: 109-14, 209-3, 210-7, 308-15, 308-16, 308-17.

Take-home product: shaker flashlight

Segment	Detail
African Proverb and Cultural Relevance (5 min.)	"Do good because of tomorrow." Ghana
Pre-test (10 min.)	Introduce a Shaker Flashlight. (Pass it around) What is a magnet? How does it work? Show a magnetic field.
Background (10 min.)	Introduce students to components of the shaker flashlight and outline their functions. Focus on circuit parameters.
Activity 1 (10 min.)	Make an AC generator Introduce simplified equations: wire loops + metal rod + magnet = Induced current.
Activity 2 (15 min.)	Introduce full-wave rectifiers and their uses, guide students into building their own.
Activity 3 (20 min.)	Assemble the components of the flashlight and test them.
Post-test (20 min.)	Reassemble and discuss exercise. Ask and answer questions. Similarities and Differences between AC and DC. Similarities and Differences between Electromagnets and AC Generators.

Suggested interpretation of proverb: This lesson teaches about the parts of the forever flashlight, one in particular being the capacitor. It stores energy created from shaking the flashlight, used to power the light bulb at a later time. In a sense, the capacitor does "good" (a good job) for "tomorrow" (a later time)

Cultural relevance

Cap B. Collins

Just as we will each try to make a Forever Flashlight, the first portable flashlight ever to be invented was by Cap B. Collins. He invented the first portable pocket flashlight that burns without batteries and was patented in 1938.

His device was comprised of two cylindrical tubular sections, one being the handle section and the other, a generator section. A generator comprised spaced end plates, bars, pole pieces, shaft, bar magnets, and gear unit. A lamp supported in a reflector was at the end of the section. Wires connected the generator to the center contact of the lamp bulb.

BACKGROUND INFORMATION

Magnetic field is the space around a magnet throughout which magnetic force exists. An **electromagnet** is a device that uses an electric current to produce a concentrated magnetic field. This is different from an **induced current** which is created by crossing a magnet over a wire loop. **Electromagnetic induction** is the production of electric field or current due to change in magnetic flux.

DC stands for direct current. This means a constant amount of voltage is emitted over time. Until a DC battery is exhausted, it will output the same amount of voltage. **AC** stands for alternating current. This is the type of current used in the flashlights in this lesson as well as many other electronics, like televisions and radios. AC is different from DC in that the current switches, or alternates, from one direction to the other. AC is also special because the voltage can be readily changed, thus making it more suitable for long-distance transmission than DC.

Many electrical devices—like light bulbs—only require that the electrons move. They don't care if the electrons flow through the wire or simply move back-and-forth. Thus a light bulb can be used with either AC or DC electricity.

A **diode** is a component that restricts the direction of movement of charge carriers. Essentially, it allows electric current to flow in one direction, but blocks it in the opposite direction. Circuits that require current flow in only one direction will typically include one or more diodes in the circuit design.

Rectifiers are constructed from diodes and are used to convert AC into DC.

A **capacitor** is an electrical device that stores the power that is generated while shaking energy. They are used in electrical circuits as energy-storage devices. We are using a super-capacitor, these can be used in place of rechargeable batteries.

The **capacitance** (C) of a capacitor is a measure of the amount of charge (Q) stored on each plate for a given potential difference or voltage (V) which appears between the plates.

The **frequency** is measured in cycles per second, and is expressed in units of Hertz (Hz). Throughout the world, AC electricity operates between 50 and 60 Hz.

Electromotive force or (**EMF**) is the potential difference produced by electromagnetic induction

LED or light emitting diode, is a small light bulb that fits easily into an electric circuit. It is illuminated by the movement of electrons in a semiconductor material.

Ammeters measure **current**. **Voltmeters** measure potential difference. The **multi-meters** in this lesson can be switched to measure either.

Activity 1: Making an AC Generator

Purpose: To apply knowledge of electromagnetic induction to generate power for the flashlight

Suggested format: students should have their individual set ups but encourage them to work in groups.

Items	Quantity (for mentor and 10 students)
1" PVC pipe (12cm each)	132cm
Insulated wire (75m each)	825m
Sand paper	5
Clear tape	1
1"x $\frac{1}{8}$ " Neodymium (rare earth) magnet	11
Multi-meter	1
Plugs	22
Alligator clips	22
Saw (for cutting pipe)	1

Procedure:

1. Cut a piece of pipe, 12cm long, and seal one end of it with a plug.
 - a. Make the plug by round-taping a small crumpled piece of paper to cushion the magnets when they hit the ends.
2. Attach one end of the insulated wire to the side of the cap on the pipe.
3. Make loops around the pipe with the insulated wire.
4. After fully winding all the wire around the pipe, attach the end to the side of the cap.
5. Sand of insulating material from the ends of the wire
6. Place the Neodymium magnet in the pipe and seal the other end with another plug.
7. Using alligator clips, connect both ends of wire to a multi-meter.
8. Shake the pipe with the magnets inside of it to generate electric current and voltage.
9. At this point it should become apparent the flashlight uses AC electricity- the magnet or polarity is being alternated from end to end.
10. Turn the multi-meter to the 200mA to measure current generated and then to 20V to measure voltage generated.

Pre-wrap the pipes with the insulated wire.

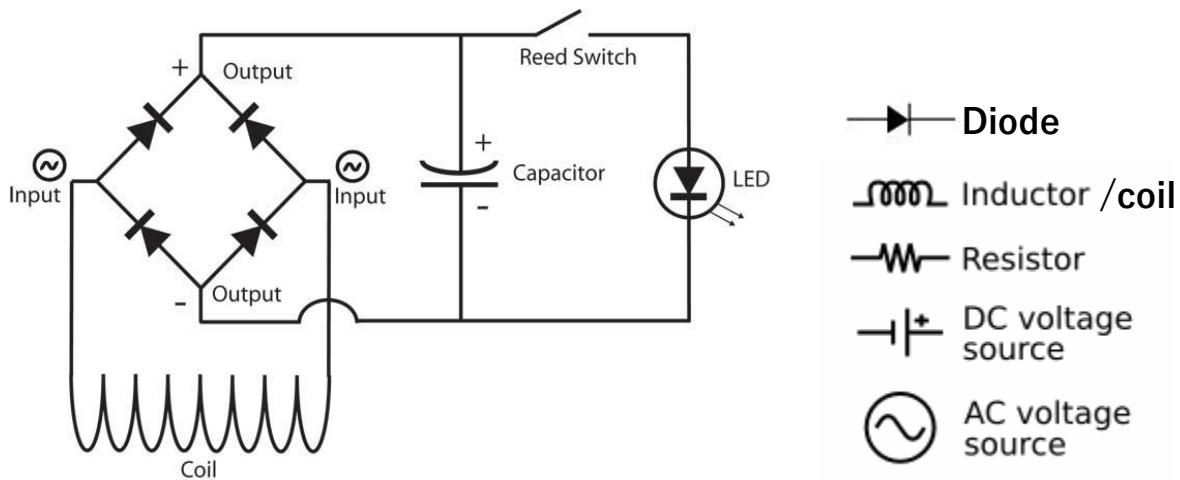
Video: <http://www.youtube.com/watch?v=tHg51GOzCXU>

Activity 2: Making a Full-Wave Rectifier

Purpose: To be familiar with some circuit elements and their functions

Suggested format: although every student should have individual set-ups, encourage students to work in groups.

Item	Quantity (for mentor and 10 students)
Diode (4 for each person)	44
Bristol board	1 sheet



Procedure:

1. Cut about 1.5"x1.5" of the hard paper
2. Using a push pin, punch a hole on the 4 corners (such that if lines are drawn connecting hole to hole a square will be drawn.)
3. Push the diode leads into the holes, taking note of their **polarity and direction** (all bands on all diodes should face the direction shown in the circuit diagram.)
Every hole should have two leads from two different diodes.
4. Link up the two leads in each hole.
5. **Follow the diagram** in order to make sure polarity is right.

Activity 3: Completing the- shaker flashlight

Purpose: To understand how a shaker flashlight works by assembling one

Item	Quantity (10 students)
LED	10
Switch	10
Super Capacitor 5,5V	10
1 1/2" PVC cap (2 x 5 = 10)	20
Plastic Straws	10

The major components of a flashlight are:

1. Hand Generator: an AC generator
2. Full Wave Bridge Rectifier: made up of diodes and it rectifies polarity.
3. Super-capacitor: stores electric charge.
4. Switch
5. LED: a diode that emits light.

Now that an AC generator and a Full-wave rectifier bridge have been made, assemble a complete circuit consisting of the **AC generator**, **Bridge Rectifier**, **Capacitor**, **Switch** and **LED** as shown in the circuit diagram above.

Remember to follow circuit diagram.

1. Using the AC generator as a base, connect the 2 ends of the coil to the input points of the Bridge Rectifier.
2. Using a wire, connect the positive output of the Rectifier to the positive terminal of the capacitor and one terminal of the switch.
3. Connect the free point of the switch to the positive LED terminal.
4. Using another wire, connect the negative output of the Rectifier to the negative terminal of the capacitor and the positive terminal of the LED.

Answers:

1. L I G H T E M I T T I N G D I O D E
5

2. D I R E C T C U R R E N T
3

3. M U L T I - M E T E R
6

4. L I G H T B U L B
1

5. V O L T A G E
2

6. F R E Q U E N C Y
7

7. C A P A C I T O R
4

Bonus

B	A	T	T	E	R	Y
1	2	3	4	5	6	7

Useful links

- <http://www.codinghorror.com/blog/2006/04/uml-circuit-diagrams-and-gods-rules.html>
This page contains the diagram used in the lesson showing the electric symbols.
- http://www.play-hookey.com/ac_theory/
This page compares alternating and direct current. Includes applications of both.
- <http://www.shake-flashlights.com/how-they-work.html>
This site explains how shaker, or faraday, flashlights work. Includes a diagram as well as gives background information on these AC operating systems work.
- <https://electronicsclub.info/leds.htm>
Explains the components of LED bulbs as well as applications
- <http://www.school-for-champions.com/science/ac.htm>
This page fully explains AC as well as compares and contrasts AC to DC