Delving into the Electrical Domain: Adding the Piezoelectric Effect and Diodes into the High School Physics Curriculum

Internet of Things (IoT) at UCF

UNIVERSITY OF CENTRAL FLORIDA

UCF RET Site: Collaborative Multidisciplinary Engineering Design Experiences for Teachers

Physics-Electricity Unit

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READ THIS FIRST

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- Remember to do your 3R reflection include an updated copy of your lesson plan, developed assessment tools, presentation materials, to the evaluator. See implementation plan instructions developed by the evaluator. Send within a week after completing the lesson to bonnie.swan@ucf.edu

RET Site: CoMET Lesson/Unit Plan

Course(s): Physics
Grade Level: 9-12
Suggested Length of Lesson: 10 days

Materials/Technology Needed

- **SMART Board set up**
- **Individual Computer/Internet Connection**
- **Logger Pro Software**
- **Vernier Probes &/or Multi-meters**
- **Lab Supplies-see each lab for materials**

Where this Fits

- This is a unit on Electricity.

These activities will be tests on Regular Conceptual Physics classes. Pieces will also be tested on AP Physics 1 and AP Physics 2 classes.

Lesson Objective(s)/Learning Goal(s)

- Explain how a piezoelectric material can generate a potential difference, thus current, and relate it to the Coulomb's Law.
- The students will be able to explain what makes a material a conductor, insulator or semi- conductor.
- Explain how/why doping affects the conductivity of a material.
- Explain how a diode works.
- Students should be able to give examples of applications of both the piezoelectric effect and diodes.

Standard(s)/Benchmark(s) Addressed

SC.912.P.10.1: Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.
SC.912.P.10.13 - Relate the configuration of static charges to the electric field, electric force, electric potential, and electric potential energy.
SC.912.P.10.14 - Differentiate among conductors, semiconductors, and insulators.
SC.912.P.10.15 -Investigate and explain the relationships among current, voltage, resistance, and power.

Standards for Mathematical Practice

- Reason abstractly and quantitatively.
- Use appropriate tools strategically.
- Make sense of problems and persevere in solving them.

Instructional Strategies

- Exploratory Stations
- Problem Based Learning
- Group Discussion- Think Pair Share
- Computer Simulation
- Direct Instruction
- Hands-on Lab Activities
- Drill/ Practice
- Summary
- Chunking

Evidence of Learning (Assessment Plan)

- Notebook Entries- various
- Lab Reports and/or Products
- Problems/Graphs/Diagrams
- Essay
- Formal Test

Description of Lesson Activity/Experiences

Day 1: Static Electricity Stations-

- Students will move around the station trying the activities.
- Students will document each station with a picture and a caption
- Exit Ticket submit station assignment.

Day 2: Van de Graaf Generator

- Students will observe and try the demonstrations.
- Students will participate in a class discussion and write an
- Exit ticket. 2 things you learned one question you still have or that you think will be on the test.

Day 3: Coulomb's Law and charge distribution

- Students will explore the PHET simulation https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html interaction page- show forces
- Coulomb's Law Notes and Practice textbook
- Exit Ticket: Practice quiz Coulomb's Law

Day 4: Piezoelectric effect Demo & Project Challenge:

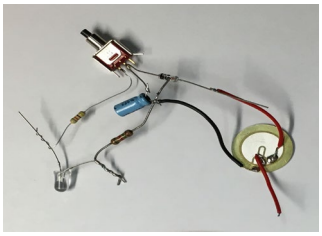
- Review Coulombs law and energy transformation and introduction to current
- Electric Field- Potential Difference Define Charge, Potential Difference, Current
- Piezoelectric Lecture and Demo and Problem: The LED is very, very dim.
  How can you make the LED glow more brightly?
- Internet Research: Examples of uses of the piezoelectric effect.
- Exit Ticket: List examples of piezoelectric uses.

Day 5: Components Resistors, switches, batteries, Capacitors –storing charge

- Slide presentation: How does a computer work?
- Drawing and Defining components
- Make a capacitor and a simple LED paper flashlight circuit with Bareconductive Paint
- Exit Ticket: How will a capacitor and switch help make the LED glow brighter?

Day 6: Resistors in series and parallel Lab

- Equivalent resistance and Ohm's Law
- Practice Math Textbook
- Exit Ticket: Quiz Find equivalent resistance



Day 7: Building simple Circuits Lab

- Make series circuit 2 light bulbs
- Exit Ticket: Submit Lab report

Day 8: Diodes

- Lecture
- Cloze Activity
- Exit Ticket: How does a diode work?

Day 8: **Putting it together: How can you make the LED glow more brightly?**

- Make the new device and
- Essay question: explain what each component does and how it helps solve the problem of making the LED glow more brightly.

- Think Pair Share
- Exit Ticket: Revised Essay question

Day 9: Wrap up Day

- Remedial: catch up
- Standard: Review
- Enrichment: Complex circuit diagrams Textbook

Day 10: Posttest embedded in the unit test.

Recommended Assessment(s) and Steps

- Stations notes
- Exit Tickets
- Lab Reports
- Summary and practice prompt
- Post Test/ Unit test

List of Materials/Resources Used

- PVC pipe, wool silk, sink, empty soda cans, salt/pepper on plate,
- Computer/Internet Connection
- Van de Graf generator demonstration materials
- Pennies, nickels, lemons juice/vinegar, wax paper, wires and multi-meter
- Aluminum Foil, wax paper, Tape, Graphite pencil "lead" or bare conductive paint, LED
- Button Switch, LED, Resistor, Capacitor, Diode, wire, piezo generator, soldering iron/solder or breadboard
- Light bulbs, wire, multi-meter

You can create multiple lesson plans if you are developing a unit.

Important Vocabulary

Define unusual or probably unknown words. Write definitions in sentence format.

Term	Definition

Charge is a fundamental physical property.
A conductor is a material that allows its own free electrons to move through it.
An insulator is a material that does not have free electrons so they cannot support a current.
A semiconductor is a material that does not have free electrons in the conduction band but can be coaxed into conduction through doping.
Doping is the process of adding impurity atoms into an otherwise pure crystal lattice.
Holes are places in a crystal lattice where electrons are missing according to the octet rule.
A capacitor is a device consisting of 2 parallel conducting plates separated by a distance that is used to store charge.
A dielectric is the insulating material between the 2 parallel plates of a capacitor.
A diode is a p-n semiconductor device used to limit current flow to one direction.
A LED is a light emitting diode.
Ohm's Law says that the potential difference is proportional to the current.
Current it the flow of positive charge or holes.
Voltage is the potential difference between two points.
Electric Field is the force point charge would feel if it was at any point in space in the vicinity of a Charge
Resistance is a measure of how much current is restricted.
Piezo electric effect is the process of applying pressure to a crystal lattice that causes a current to be induced in the lattice.

Troubleshooting Tips

Add anything helpful here.

Rather than soldering the pieces together use a breadboard.

Other Helpful Information

Taken from OCPS Scope and Sequence Data Sheet

- define and contrast properties of conductors, semiconductors, and insulators
- describe what makes a material a good conductor or insulator (e.g., stability of valence electrons)
- describe the process of doping and how it alters the conductive properties of a material
- define current, voltage, resistance, and power
- use Ohm's law to explain the relationship between current, voltage, and resistance
- quantitatively relate power to current, voltage, and resistance
- explain the relationships among power, energy, and time

Add anything helpful here.

I wish to incorporate segments from
Junior Jn-Baptiste's 2017 RET lesson on piezo resonators and
Jim Ebbert's 2017 RET lesson on Logic Gates to supplement this lesson plan
Chad Hobby's 2017 RET Lesson on resistivity
Into my high school physics curriculum as well.

Useful Websites:

dagoma92 "Ubiquitous Computing" https://youtu.be/0Re5YNyihiw
Piezo generator device
Ludic Science https://www.youtube.com/watch?v=ACsy6xSIBm8&feature=youtu.be

Diode lessons www.learn.sparkfun.com

Bareconductive paint demonstrations

Demonstration: https://www.youtube.com/watch?v=4HdRGaZ0bIQ

Demonstration 2: https://www.youtube.com/watch?v=pVvEQUbhar8

Attachments

List here any lesson or activity attachments not included within this document, such as the following:

Supplementary Materials

1. Pre-test/Post-test Answer Key
2. Electrostatics Explore Lab Stations
3. Light Emitting Diode Power point
4. How computer works! Power point
5. Diode Cloze Assignment
6. Poster Presentation/Overview

Remember to send these as separate files along with your unit/lesson plan.

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List here using APA format

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