Wireless Power Transmission for AP Physics

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TEACHING MUTUAL INDUCTION WITH HANDS ON WIRELESS POWER TRANSMISSION

A lesson, lab activity and research assignment to instruct and engage AP Physics students with Wireless Power Transmission (WPT)

OBJECTIVES

AP Physics C- Electricity and Magnetism, Grades 11-12

- Students will participate in a lesson on magnetism and mutual induction.
- Students will understand how electricity can be transmitted without wires.
- Students will follow instructions to build a basic wireless power transmitter.
- Students will utilize the engineering design process to optimize their transmitters.
- Students will research applications for wireless power transfer.

OVERVIEW

Students will have to use their prior knowledge of electrical circuits, magnetic fields and the behavior of charged particles in a magnetic field. After participating in a lesson on magnetism and mutual inductance the students should understand how a wireless power transmission (WPT) system works. A guided inquiry activity will prepare students to take their designs further on their own to develop and optimize a functional WPT system. Students will conclude the lesson by researching applications for WPT in modern devices and homes. This activity should take approximately 3 days. The lesson will be presented on day one. Creating and optimizing the WPT systems will take the second day. The final day will be spent researching applications for this technology. If time is short, research may be assigned for homework on the night between the lesson and lab activity.

ENGINEERING CONNECTIONS

Working from instructions provided by the teacher, students will create their own wireless power transmission system. Students should work in groups of 2 or 3. Students will work with provided materials and instructions to build a basic WPT set up. Then students will utilize other materials and configurations of their choosing to optimize power transfer. Students should consider the following engineering design process questions as they work:

- How does it work? Create an illustration of the process.
- Which components of the set up are variable? Identify the change that would result from modifying each variable.
- What are the advantages of this set up?
- How could the set up be improved?

REFERENCES

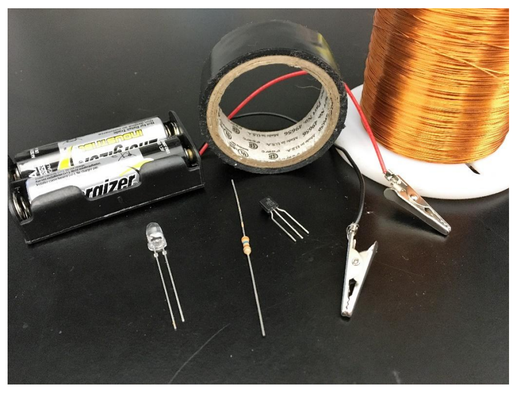
The Journal of Wireless Power Transfer
https://www.cambridge.org/core/journals/wireless-power-transfer

Research progress of wireless power transmission technology and the related problems
https://aip.scitation.org/doi/pdf/10.1063/1.4977407

Optimal design and analysis of wireless power transfer system with converter circuit
https://link.springer.com/article/10.1186/s13638-017-0813-7

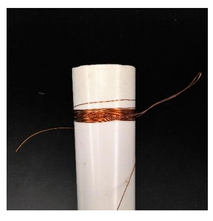
MATERIALS

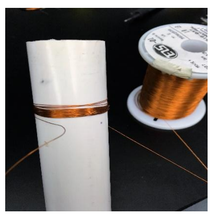
- Magnet Wire size 26-30 AWG
- AA Batteries
- 2 AA Battery Holder with wire leads
- 360 Ω resistors
- 2N2222 Transistor
- LED lights
- Electrical tape
- Ferrite Rods
- Miscellaneous electronics components



PROCEDURES

1. Build the Inducer Coil and the Receiver Coil.

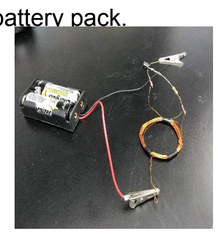




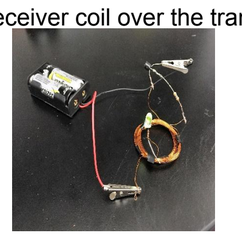

2. Connect the transistor.


3. Connect the LED.

4. Attach the battery pack.

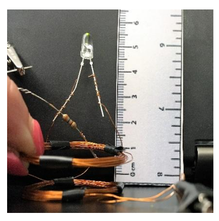
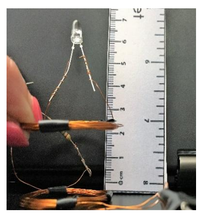
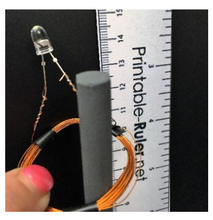


5. Move the receiver coil over the transmitter coil.



6. Make observations and collect data.

7. Decide on one variable to manipulate to improve the function of system. Write a procedure for testing the effect of changing this variable. Create a data table in which to record data. (Ferrite core here)

LESSON OUTCOMES

Students will be able to explain what they have learned about wireless power transmission, it's limitations, current developments and applications within real-world situations. They will describe what a highly coupled induction system is used for and how it works. They will outline the ways in which resonant systems vary from inductive systems. Students will list several challenges and benefits to both methods. Students will be able to apply their knowledge to solve College Board style free response problems.