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TRANSFORMERS

AP PHYSICS II

Driving Question | Objective

What is the most effective way to transfer magnetic fields from one coil to another?

Materials and Equipment

Coils

Iron cores

Voltage output device

Voltmeter

Background

In this experiment, you will observe how a changing magnetic field in the primary coil produced by a changing voltage (recorded in blue) will result in a changing voltage in the secondary coil (recorded in green) when the magnetic fields are able to loop through the secondary coil. This system is called a transformer and the process called magnetic induction.

You will also observe methods to increase the efficiency of the transformer secondary coil using the arrangement of iron cores to help guide the magnetic fields.

$$Efficiency = \frac{Recorded}{Theoretical}$$

Theoretical voltage will be calculated by dividing the number of coils in the secondary coil by the number of coils in the primary coil and then multiplying by the peak voltage through the primary coil.

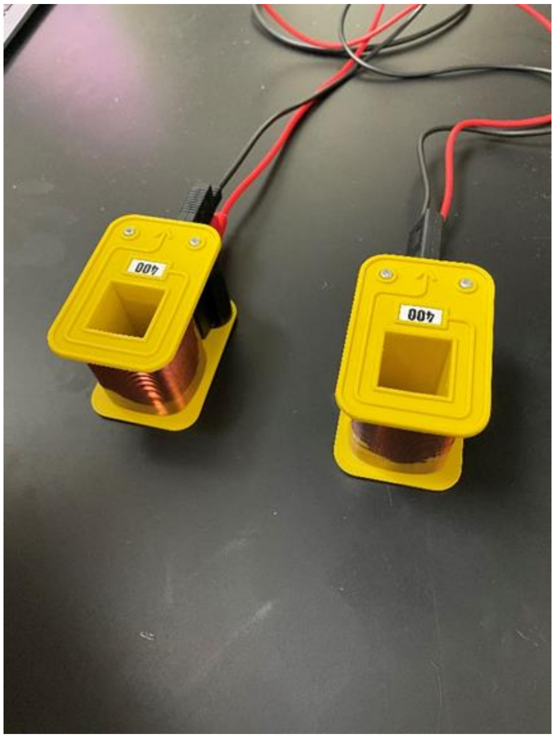
Safety

- Be wary when handling the iron cores and wiring the coils

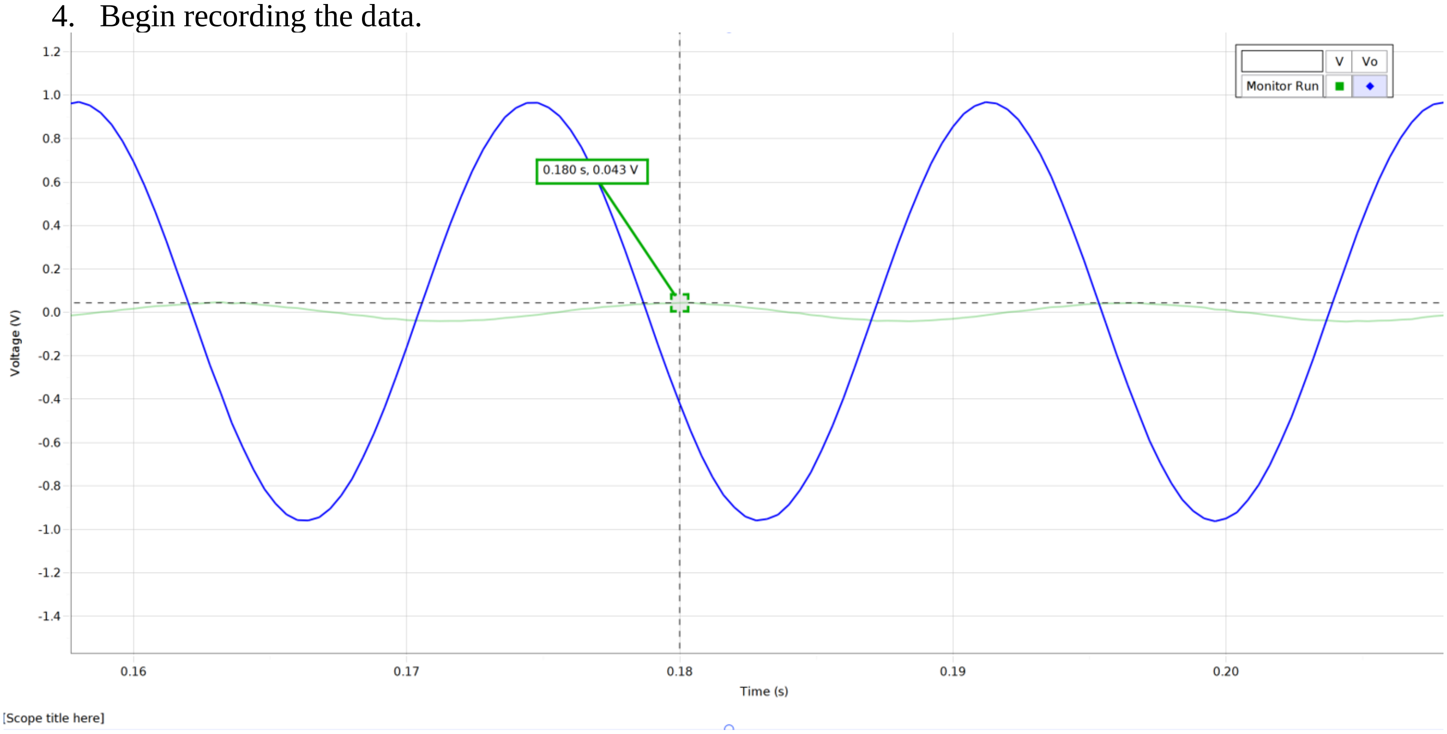
Procedure

Part 1

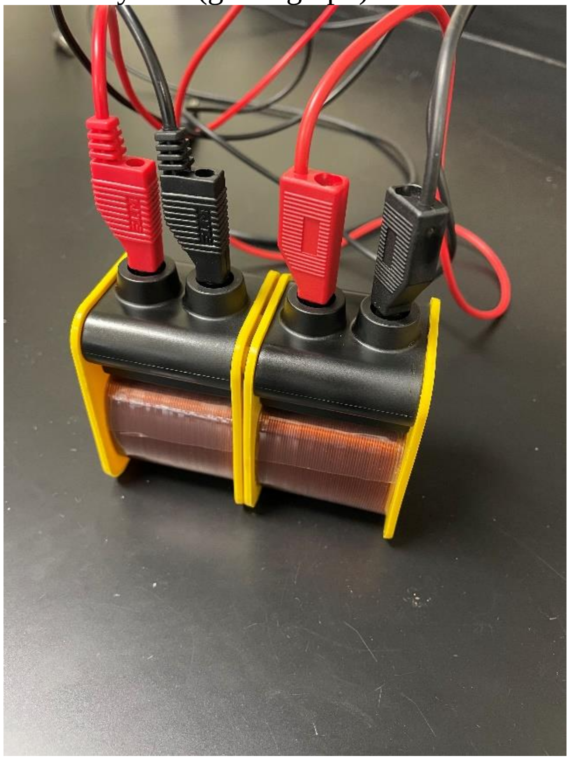
1. Open the PASCO software and turn on the terminal.
2. Connect the wires from the voltage output (right of the terminal) into a 400 coil. This coil will be the primary coil.
3. Connect wires leading into the voltmeter (middle of the terminal) into the other 400 coil. This will be the secondary coil.



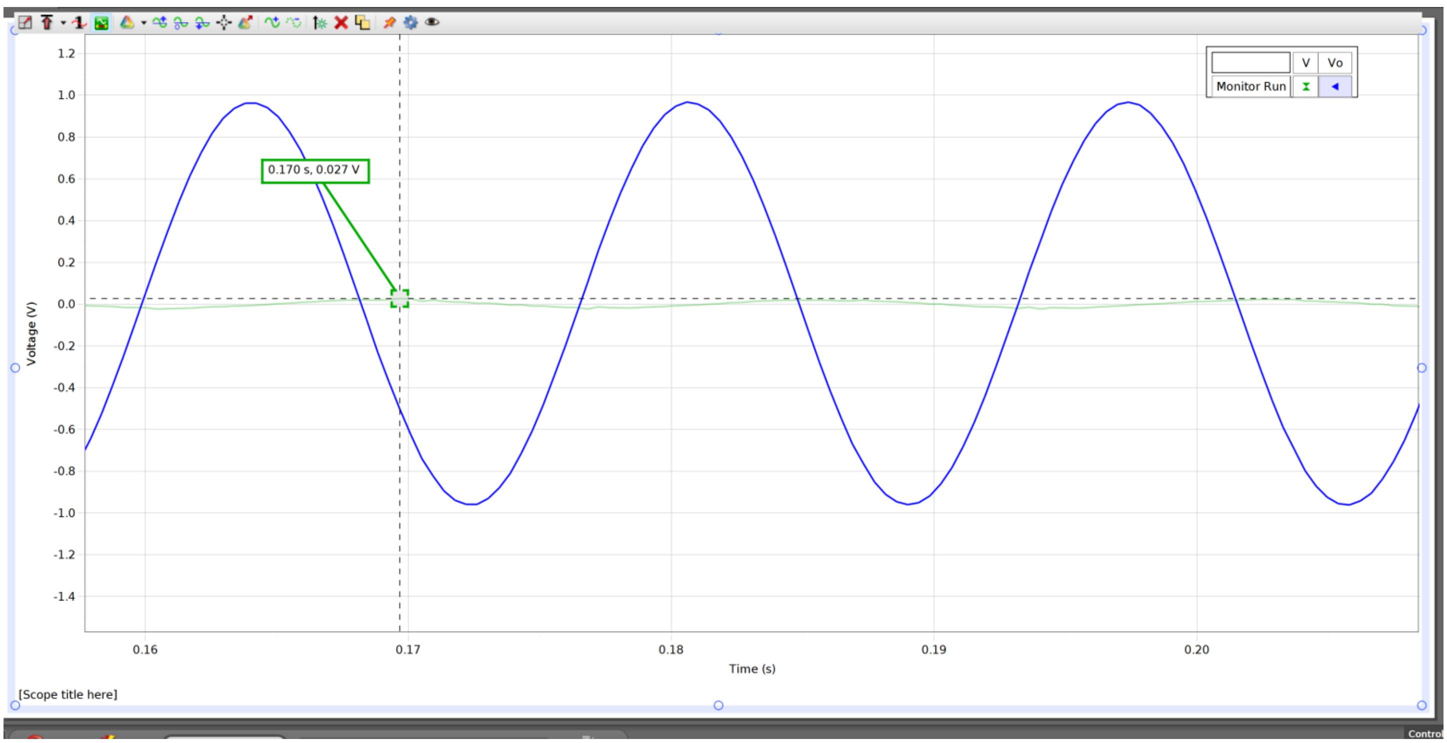
4. Begin recording the data.

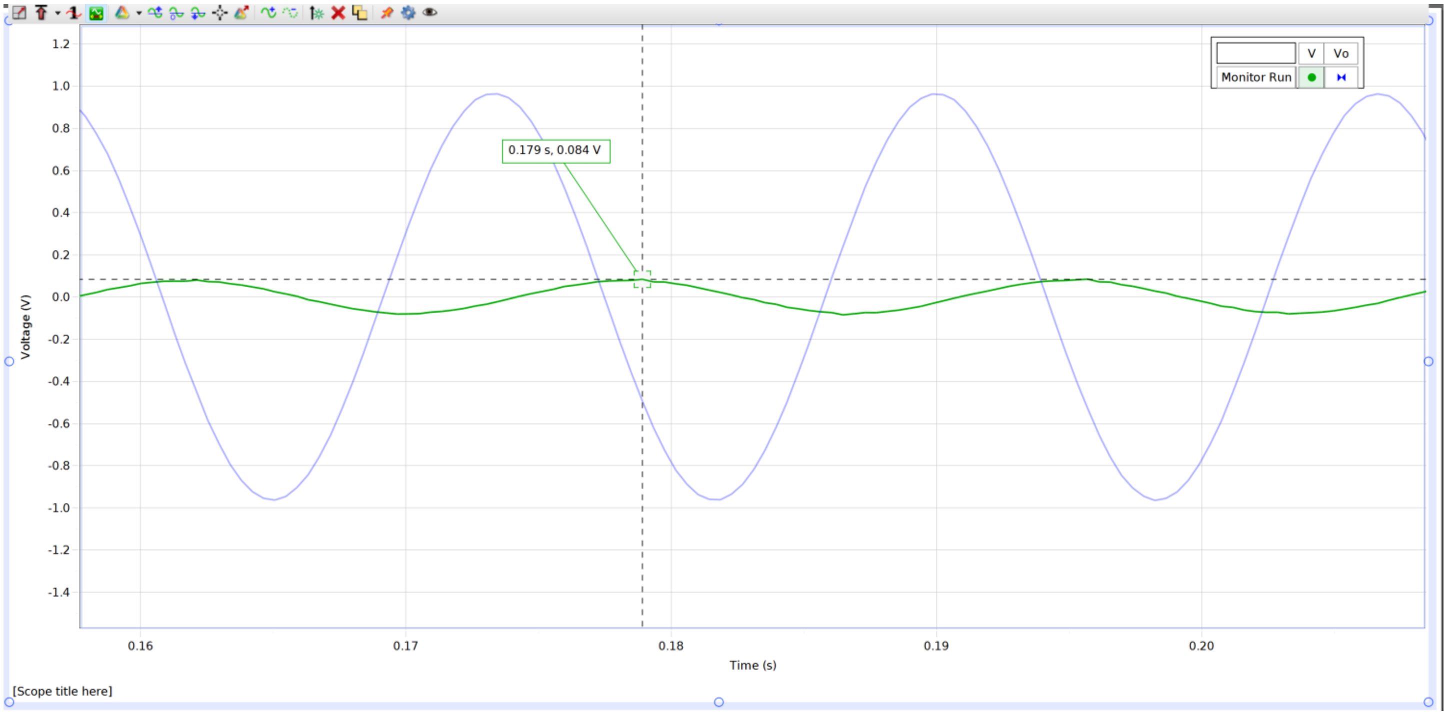


5. Place the 2 coils next to each other as indicated in the image and record the maximum voltage of the secondary coil (green graph) and calculate the efficiency of the transformer.



6. Repeat steps 3-5 for the 200 and 800 coils.





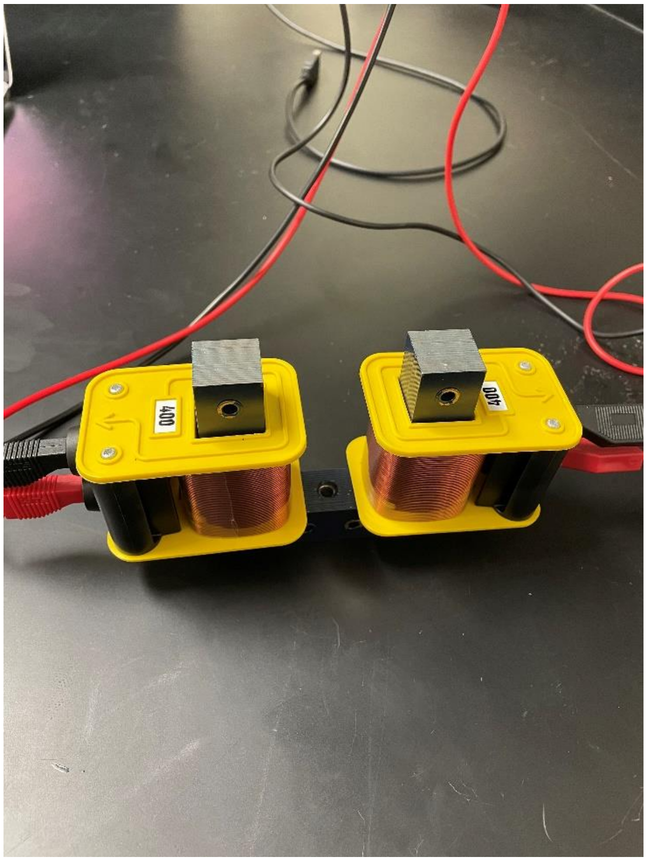
Part 2

1. Remake the transformer with both 400 coils.

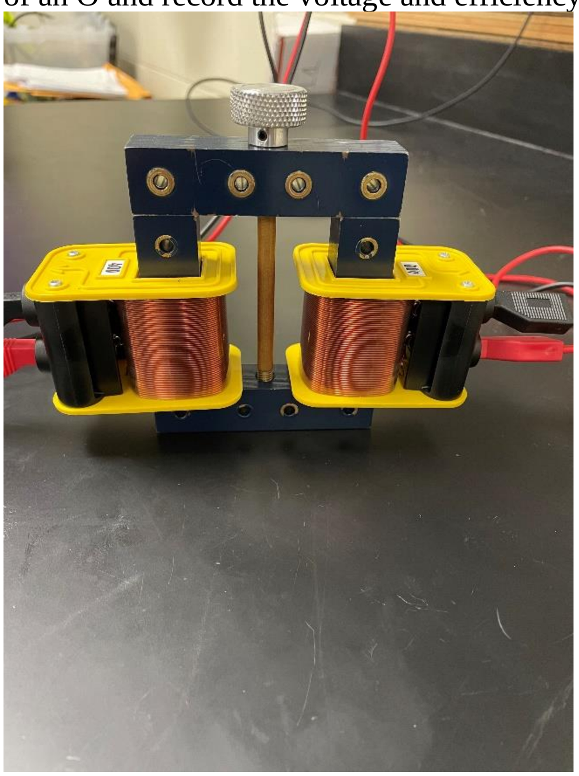
2. Take the bar shaped iron core and insert it into the transformer.

3. Record the voltage and efficiency.
   Voltage is 0.440V
   Efficiency = 44%

4. Use the U shaped iron core and build the transformer as shown and then record the voltage and efficiency once again. Record the voltage and efficiency
   Voltage is 0.147 V
   Efficiency = 14.7 %

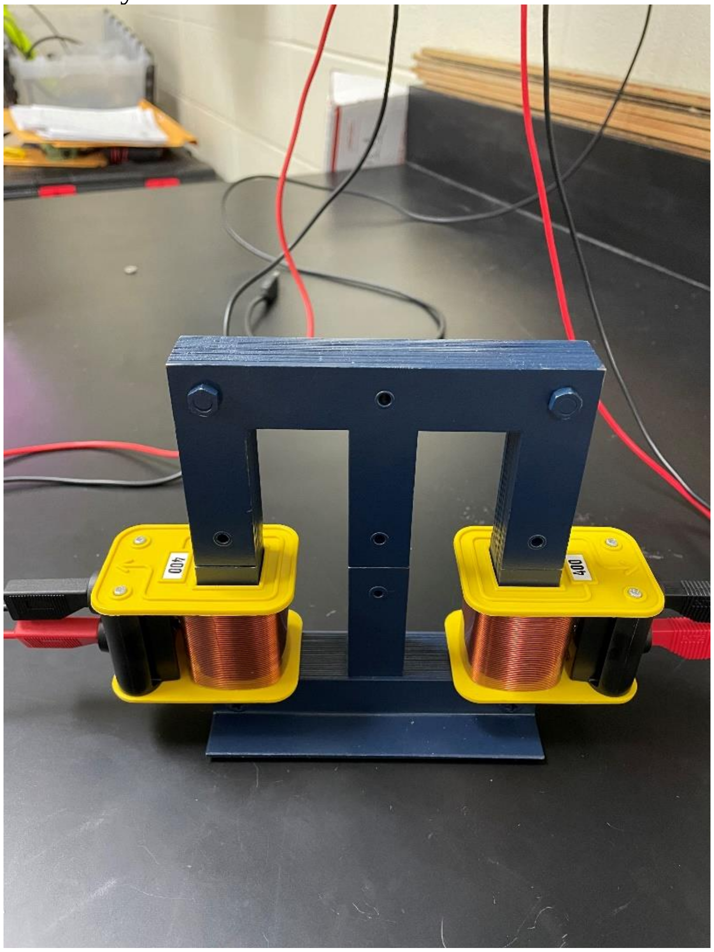


5. Now construct this transformer (the pin in the middle is optional but helps keep it together) in the shape of an O and record the voltage and efficiency.

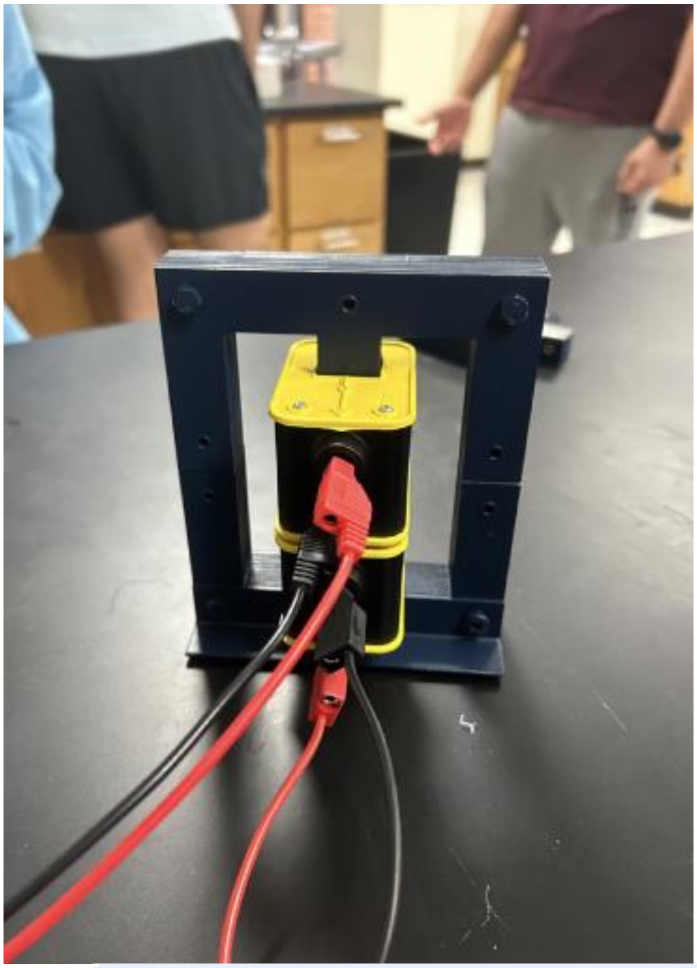


6. Next, take the E shaped iron bar and E shaped with base in order to build this transformer and record voltage and efficiency.
Voltage = 0.238

Efficiency = 23.8 %



7. Now, rearrange the coils until you find the most efficient setup. Take a picture of your arrangement and attach it below by clicking on the icon and uploading your image..



Data Analysis

	400 coil	200 coil	800 coil
Peak Voltage	.043	.027	.084
Efficiency	4.3%	2.7%	8.4%

	Air Core	Iron Bar	U-Shaped	O-Shaped	Your most efficient setup.
Peak Voltage	.043	.44	.147	.238	.831
Efficiency	4.3%	44%	14.7%	23.8%	83.1%

Analysis Questions

- Why aren't transformers 100% efficient?

Flux can be lost to the environment due to loss of current within the wires. This would result in output being less than input.

- What is done to the voltage passing through the primary coil in order to produce a magnetic field?

Magnetic flux increases and decreases leading to a change in magnetic field which produces motional emf/voltage.

- The shell transformer is made by looping conductive material around the coils until the coils are surrounded, effectively forming a "shell". Why do you think this increases the efficiency?

The looping conductive material forming shell like shapes surrounding the coil increases the efficiency by keeping as much input inside the loop as much as possible, reducing loss of voltage to surrounding, therefore allowing maximum output voltage out of the coils, which is directly proportional to efficiency. (efficiency = output / input)

- What happens to the efficiency of the transformer as the number of coils in secondary coil is increased without changing any other factors?

Efficiency increases when the numbers of coils increase.