NAME PERIOD DATE

PROPERTIES OF DIODES

How does a diode respond when a voltage is applied to it? What happens to the current passing through the diode if the voltage changes? What happens if the voltage is reversed? Investigate these questions using a diode circuit with a variable voltage source.

Objectives

- Investigate the characteristics of a diode in a circuit using current and voltage sensors.
- Use the data and observations to describe diode behavior.

Materials and Equipment

- Data Collection Software
- PASCO Essential Physics Modular Circuit Kit
- PASCO Wireless AC/DC Module

Safety

Follow regular laboratory safety precautions.

Procedure

1. Construct the circuit shown in Figure 1 using the circuit modules, wireless current sensor module, and the wireless AC/DC module. Note the polarity of wireless current module connections. Leave the switch open for now.

2. Connect the diode found in the Modular Circuit Kit accessory bag to the spring clips. It is a small black cylinder with wires coming from each end. Make sure to connect the end WITHOUT the grey band to the + terminal of the wireless AC/DC module. See Figure 1.

3. Connect the wireless voltage sensor across the spring clips, making sure the + lead is connected to the side closest to the + terminal of the wireless AC/DC module.

4. Turn on the wireless AC/DC module, the wireless current module, and the wireless voltage sensor.

5. Start your data collection system and connect it to the wireless AC/DC module, the wireless current module, and the wireless voltage sensor.

6. Create a graph showing 3 plot areas, output voltage sensor voltage, wireless voltage sensor voltage, and wireless current module current, all on the same horizontal time axis as shown in Figure 2.

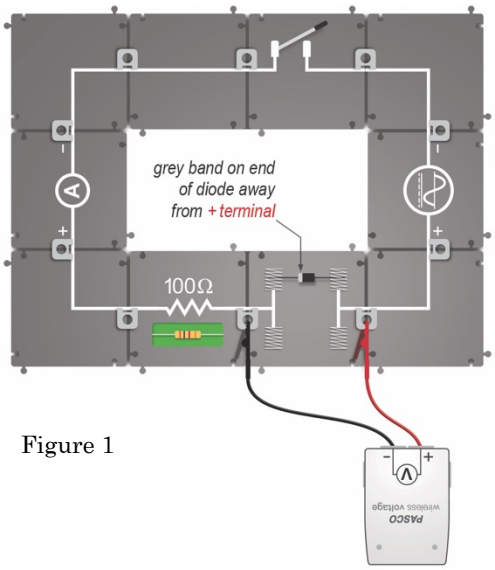


Figure 1

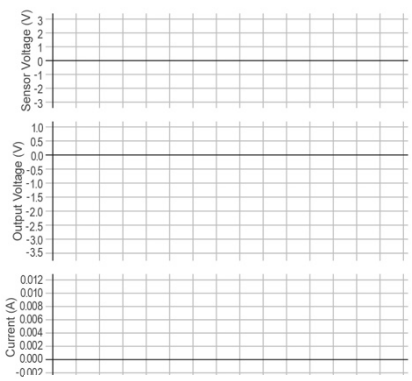


Figure 2

7. Zero the output voltage sensor, the wireless current module and voltage sensor using the data collection software.

8. Select a common rate for data collection of 50 Hz using the data collection software.

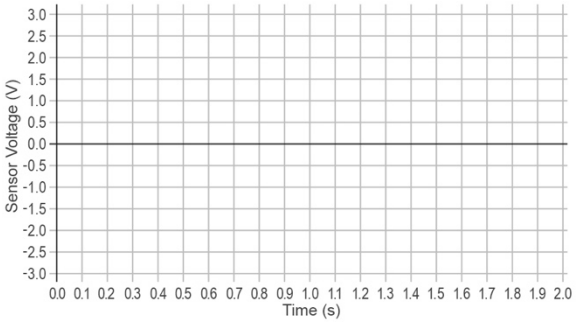
7. Configure the wireless AC/DC module output using the signal generator menu. Select triangle for the waveform, 0.5 Hz for the frequency, and 3 V for the amplitude. Click the On button and close the signal generator tab.

8. Close the switch on the circuit and start data recording. Collect data for about 4 seconds, then stop. Turn off the AC/DC module in the signal generator window and open the switch.

9. Adjust the axes limits of your graphs so that the data fills up most of the screen. Check to make sure that when the output voltage (top graph) is positive, the voltage sensor reading (middle graph), and the current (bottom graph) are also positive. If not, double check your circuit and sensor connections and repeat the data collection.

Questions and Analysis

1. Study the graph of output voltage (top graph). This is the voltage generated by the wireless AC/DC module. The pattern is known as a triangle wave. It is a type of alternating current (AC). Using the tools of your data collection software, determine the period, frequency, and amplitude of this wave. Show your work and results below, then sketch the first 2 seconds of data on the axes below.



2. Study the graph of the voltage sensor voltage (middle graph). This is the voltage drop across the diode. How is it similar to the graph of the output voltage (top graph)? How is it different?

3. Study the graph of current (bottom graph). This is the current going through the circuit, including the diode. When the output voltage is negative, what is the current through the diode? Does the current have this value at any time where the output voltage is positive?

4. Use the data analysis tools on your software to display the value of the output voltage just before the current rises above zero and record it below. A more accurate result will be attained by

zooming in on this region of the current graph. This is called the forward voltage. When the applied voltage rises above this value, the diode starts to conduct current. For silicon diodes, this value is about 0.7 V. For germanium diodes, it is about 0.3 V. Based on your data, what type of diode is in your circuit?

5. When the output voltage is negative across the diode it is called a reverse bias. Describe the current through a diode that has a reverse bias below.

6. When the output voltage is positive across the diode it is called a forward bias. Describe the current through a diode that has a forward bias below.

7. Describe below how the voltage across the diode changes when it has a forward bias. What is the maximum value of the voltage across the diode when it had a forward bias?

8. The circuit has a 100 Ω resistor. Use the data collection software to find the maximum output voltage, it should be close to 3 V. This value is the amplitude of the triangle wave from the answer to question 1. Using Ohm's law, calculate the maximum current that could flow through this circuit. Show your work below.

9. Use your data collection software to find the maximum value of the current from the graph and compare it to your answer in question 8. What could explain the difference?

10. The current through the circuit is less than the value found in question 8 because the diode has a resistance too. However, the resistance of a diode varies with the applied voltage. Use the values found from the graph and Ohm's Law to find the resistance of the diode when the voltage is maximum. (Hint: find the total circuit resistance first). Show your work below.

11. Use the value from question 7 for the maximum voltage across the diode with forward bias, the maximum current, and Ohm's Law to find the resistance of the diode when the voltage is maximum. It should compare well with the value you found in question 10. Show your work below.

12. Summarize the behavior of a diode in a circuit with voltage that changes its value and direction below. Use the terms current, voltage, forward bias, and reverse bias.

13. The diagram below shows how a check valve operates. A check valve is used to allow water or other fluids to pass through a pipe in only one direction. Describe how a diode is like a check valve below.