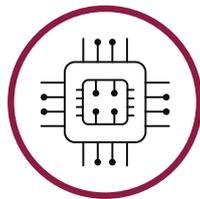
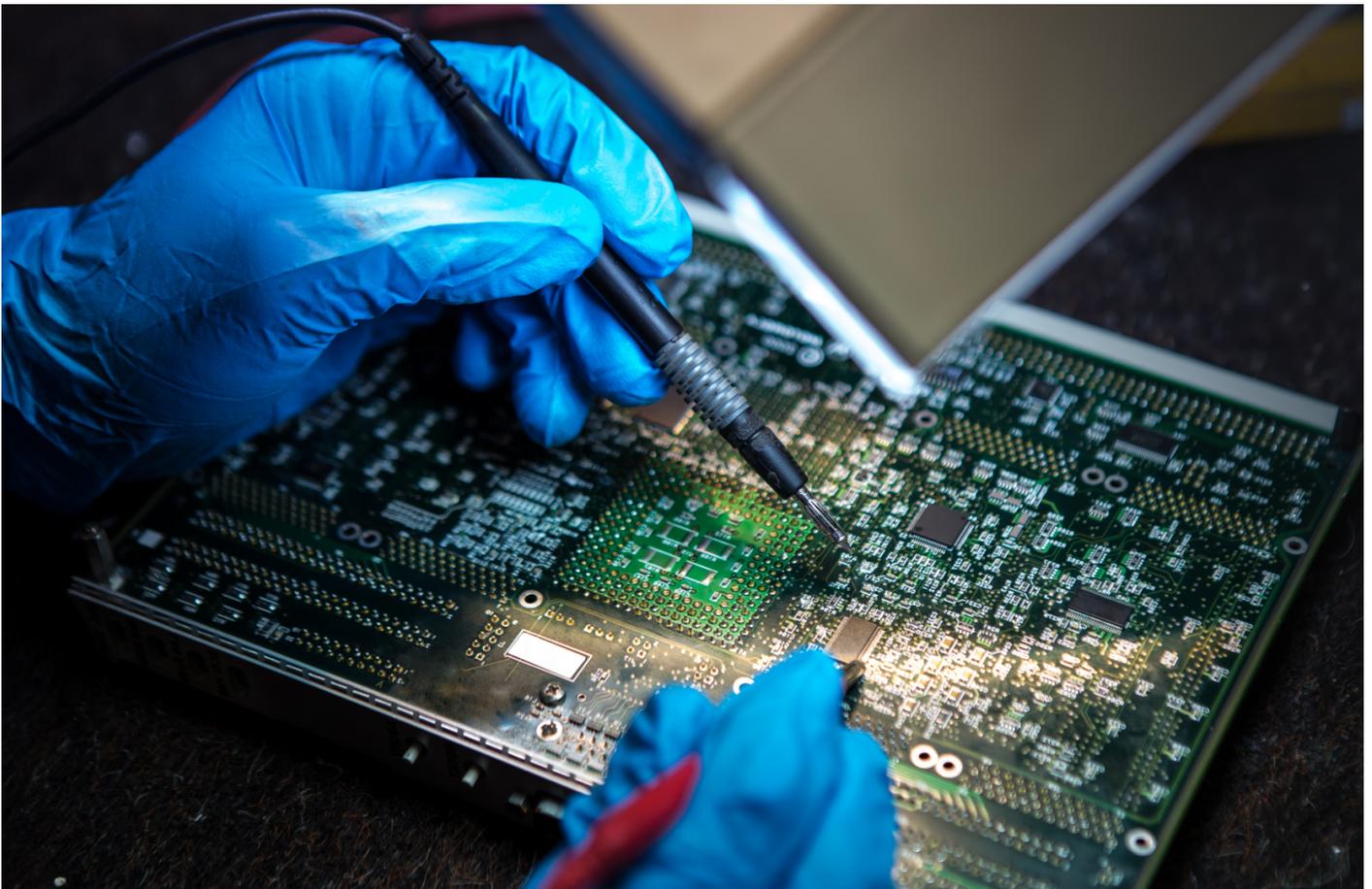




# SEMICONDUCTORS

## Lesson 4: A Beginner's Guide to Back End Assembly and Functions



### Facilitator Guide

#### How to Prepare for This Lesson

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## About This Facilitator Guide

This facilitator guide provides instructors with the information needed to guide students through the digital version of A Beginner's Guide to Back End Assembly and Functions.

### Before You Get Started

Before you get started with this lesson, please be sure to do the following:

- Read through the facilitator guide
- Review the Rise lesson
- Prepare any resources needed for the lesson

### Using Editable PDFs

Most lessons include using an editable PDF for students to capture responses to questions and other activities.

Guiding language is included in the lesson to help students access and use the editable PDFs where they appear.

Students who will be using Chromebooks will need to use the Print to PDF function to save their editable PDFs to their devices. Here's how to do this:

1. Open the editable PDF and select Ctrl + P.
2. Open the file destination where the file will be saved.
3. Select "Save as PDF."
4. Select "Print." Your document is now "printed" as a PDF file, which will save your work.

PDFs cannot be submitted via the Rise interactives. If you plan to collect these documents for career planning portfolios or grading, you will need to coordinate that with your students.

### Unit Overview and Alignment of Learning Targets

This unit contains five lessons, as follows:

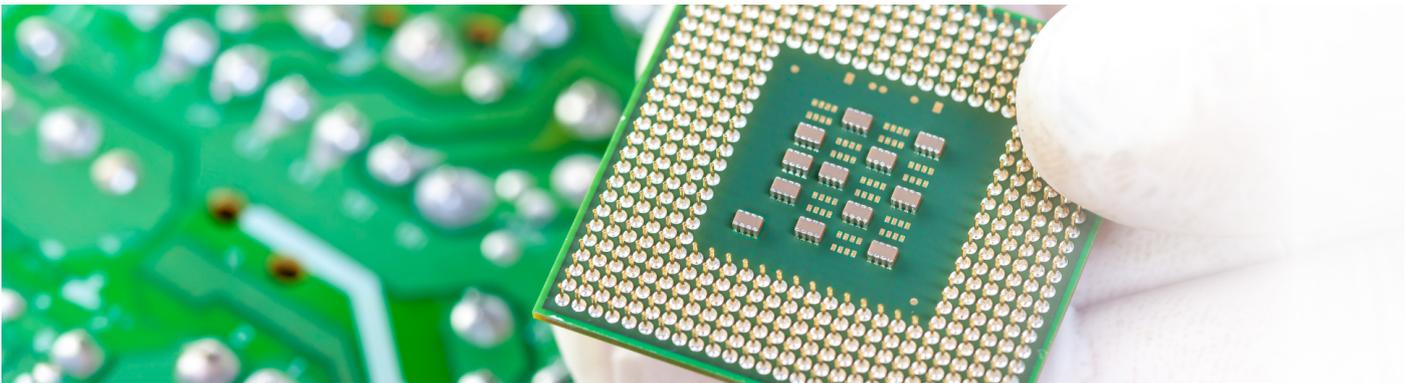
- Lesson 1: Introduction to Semiconductors
- Lesson 2: The Magic of Raw Materials and Design
- Lesson 3: Fun With Front End Design and Machinery
- Lesson 4: A Beginner's Guide to Back End Assembly and Functions
- Lesson 5: The Future of the Semiconductor Industry and My Place in It

For students to get the most value from this unit, please plan on implementing all lessons in this unit in sequential order.

### **Tracking Completion of Lessons**

If you are using SCORM Cloud or Canvas with the lessons in this unit, completion tracking options are available. If you are not using either platform, please determine if and/or how you plan to track the completion of lessons by the students.

## **Lesson 4: A Beginner's Guide to Back End Assembly and Functions**



### **Lesson 4 Components**

#### **Pacing**

The lesson is designed to extend over multiple class periods to build the background knowledge students need to explore careers and to be able to answer the lesson's guiding question. You may tailor the lesson to meet the needs of the class. If you choose to teach the lesson in its entirety, plan where you will stop after each session. Prepare an appropriate debrief for that class and a way to reengage students in the activities for the next class session.

#### **Materials**

N/A

Be sure to review any Extension Activities that may be suggested at the end of this lesson and consider when and how your students will complete them.



## Guiding Questions

The guiding question is intended to provide a focal point for each lesson. This lesson's guiding questions are as follows:

- How does a finished silicon wafer get packaged as a semiconductor to be placed in a device you use every day?



## Lesson Overview

In this lesson, you will review the key phases of the back end assembly process. You will take a closer look at the steps for packaging a semiconductor before you get to explore what semiconductors do in a cell phone. Finally, you will learn about the software used to create the necessary circuits and program semiconductors to do their jobs.



## Vocabulary in This Lesson: Flip Card Activity

The flip card activity is designed to familiarize students with key vocabulary terms and definitions for this lesson. These vocabulary words are bolded throughout the lesson. Students must flip each card to proceed with the lesson.

### **Moore's Law:**

Gordon Moore noticed that the number of transistors that can fit on a new semiconductor doubles every 2 years. This observation is still relevant today.

### **Junction:**

The boundary between different semiconductor types in a transistor. A junction is like a fence between a house and a neighbor. A gate must be built into the fence in order for people to pass through.

### **Integrated Circuit:**

An assembly of electronic components such as transistors, resistors, and capacitors built into a single semiconductor chip. Think of an integrated circuit like a small Lego set. Each Lego does something different, but they are all required in order for the set to work properly.

### **Diode:**

A semiconductor device designed to conduct current in only one direction for specified voltage and current values. Are you familiar with leakproof ketchup bottles? To get the contents out, turn the bottle upside down and squeeze. To stop the flow, stop squeezing. These bottles use a one-way valve. Diodes work the same way!

**SRAM (Static Random Access Memory, Pronounced /S Ram/):**

A type of memory device that can store memory for quick removal but loses memory when power is lost. SRAM is similar to sticky notes on a desk. The information remains there until the sticky note is thrown away (power is turned off to the device).

**DRAM (Dynamic Random Access Memory, Pronounced /D Ram/):**

A type of memory typically used to temporarily store memory before it is transferred to a central processing unit (CPU). DRAM is similar to ice in a cup. More ice has to be added to keep the cup cold as the ice melts. Adding ice is the same as refreshing the memory in the DRAM.

**Learning Targets**

By the end of this lesson, students will be able to do the following:

- Examine the steps of the back end assembly process in semiconductor manufacturing
- Identify the semiconductor's role and function in electronic devices
- Explore software packages used in back end assembly and application
- Summarize the steps involved in back end assembly

## Semiconductor Packaging Process

Before starting this section, briefly review the previous lesson, where students learned about the front end process, focusing on the design and construction of silicon wafers in a clean room. In this section, students will explore the second half of this process, known as back end assembly. The graphic character, Sami, will introduce the topic to students.

After the introduction, students will watch a YouTube [video](#) explaining the semiconductor packaging process.

## The Steps for Packaging a Semiconductor During the Back End Assembly Process

In this section, students will review the steps in the back end assembly process, which takes the semiconductor from a wafer to a fully packaged product. This information is presented in a Rise course component called a timeline block.

You can also share the following additional resources with students that explain front-end design and manufacturing, as well as back end assembly, in detail.

## Additional Resources

- [https://www.st.com/resource/en/application\\_note/cd00003986-introduction-to-semiconductor-technology-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/cd00003986-introduction-to-semiconductor-technology-stmicroelectronics.pdf)



## Let's Think About It

In this section, students will reflect on what they have learned and use the editable PDF to respond to the following questions:

1. In the back end assembly process, there are many steps. Which of these crucial steps in manufacturing a semiconductor would you want to be a part of?
  - a. Wafer probing, die cutting, and inspection sorting
  - b. Die attachment
  - c. Wire bonding
  - d. Package molding

What do you find cool about this step? What do you think you would do in this step?

## Let's Take a Look at the Semiconductor Devices in a Cell Phone

In this section, students will explore the different parts of an iPhone and learn where they are manufactured by examining an image. The image is presented in a Rise course component called a labeled graphic block, where students can select markers on various components to access related information.



## Let's Think About It

In this section, students will reflect on what they have learned and use the editable PDF to respond to the following questions:

1. Pick a part of the cell phone that was discussed in this lesson. What did you learn about this part? What did you find interesting about it? Where do you see your future self?
2. Would you be more interested in the back end assembly process of building a semiconductor, or would you be more interested in using these semiconductors in a device? Explain.



## Let's Talk About It

In this section, students will begin by answering the following questions independently. They will then pair up to discuss their responses with a partner. Facilitate the discussion, providing guidance and support throughout the activity.

1. What surprised you about the back end assembly process?
2. Is there a component in your cell phone that you found cool?

## Semiconductor Programs

In this section, students will watch a YouTube [video](#) that explains how semiconductor software enables electronic devices to function.

## Software Packages

In this section, students will explore the types of software used in semiconductor development and the tasks they facilitate. The information is presented in a Rise component called a tab block, where learners can navigate between tabs by selecting each one.

You can also guide students to interact with these CAD programs, encouraging them to download the software and explaining what each link offers. For a deeper exploration, you can download the software and explore it in class.

### **AutoCAD:**

AutoCAD is available for free to educators and students with a school email address. Autodesk software packages must be downloaded and installed on a computer, so students will need access to a compatible device.

The following link leads to the Autodesk student educational resources website, where students and educators can explore everything AutoCAD offers. Most Autodesk programs can be downloaded for free with an educational email, and the site includes extensive resources for learning the software. It also highlights careers where the software is widely used.

<https://www.autodesk.com/education/students> (free with educational email)

## **Onshape**

Onshape is available for free to educators and the general public through their free hobbyist accounts. Since Onshape is a web-based platform, users only need a computer with a high-speed internet connection to access it. However, because models are stored publicly, this software should be used solely for educational purposes and not for any development work that may have patent potential.

[Explore Onshape](#)

## **LTspice:**

Anyone can download LTspice, a free software similar to the industry-leading Pspice, from the following website.

[Explore LTspice](#)

LTspice can be used to understand how circuit simulation software operates.

## **Arduino:**

Code can be learned from various resources, with W3Schools being an excellent starting point for the basics of coding. For those interested in coding microcontrollers, Arduino offers a low-cost option with free downloadable software.

[Learn about Arduino](#)

## **Which software package would you use for the following tasks?**

In this section, students will complete a “knowledge check: matching statements” exercise related to the previous topic. They will drag the beginning of each sentence to its corresponding partner in the right column to complete the exercise.



### **Let's Talk About It**

In this section, students will begin by answering the following questions independently. They will then pair up to discuss their responses with a partner. Facilitate the discussion, providing guidance and support throughout the activity.

1. Is there any part of the back end design process that you would like to know more about? Explain.
2. Can you see your future self doing any of the design processes discussed in the lesson? If so, which one?

## Thinking About Your Future

**Students will see the following statement in Rise:** In this lesson, you explored a career in the semiconductor industry.

Before moving on to the next lesson, take some time to reflect on these questions:

- What part of the semiconductor design process discussed in this lesson was interesting to you?
- Was there anything that surprised you about the semiconductors you can find in your phone?
- Which is more interesting, designing semiconductors or using them in a device? Why?

## Career Pathways

**Share the following with your students:** It's never too soon to start exploring future career options!

Students can access the resources at this link: [PipelineAZ](#)

## Lesson Completion

**At the end of the lesson, students will see the following message in Rise:**

In the upcoming lesson, you will explore the future of the semiconductor industry, review its manufacturing process, identify career paths along this process, and discover potential avenues for further career exploration.

## Extension Activities

### Activity 1: Arduino Activity



#### Materials

- Arduino Uno Board (optional; can be purchased from Amazon for 27.99 at [Arduino uno board](#))
- Arduino IDE latest version (can be downloaded to the computer from [Arduino IDE](#))
- Tinkercad (optional; sign-up and use are free, but coding is by the block as opposed to real code)
- Computer



## Prep Before the Lesson

### If Using Arduino Uno Board

Make sure that all boards are properly connected to the computers with the USB cable. Make a packet for each student with a slide switch, a mini breadboard, and two breadboard wires.

### If Using Tinkercad

Make sure that all students have a log-in for Tinkercad and know how to log in to the website.



## Vocabulary

1. **Breadboard:** A plastic board with holes in the top that circuit components can be easily plugged into. Bars inside the breadboard transmit current between components allowing for easy setup of circuits.
2. **Microchip:** A set of electronic circuits on a flat piece of silicon also called a chip, a computer chip, an integrated circuit, or IC. Your brain takes in information and sends messages to your body; for example, if you touch a hot surface, it tells you to pull your hand away. Similarly, a microchip takes in information and sends messages to other electronic devices to take action.



## Questions to Ask Before the Activity

1. How can we tell semiconductor devices what to do? How do they know what their task is?
2. Can we make an LED blink by sending commands from our computer?
3. What would you like to know about programming Arduinos?



## Procedure

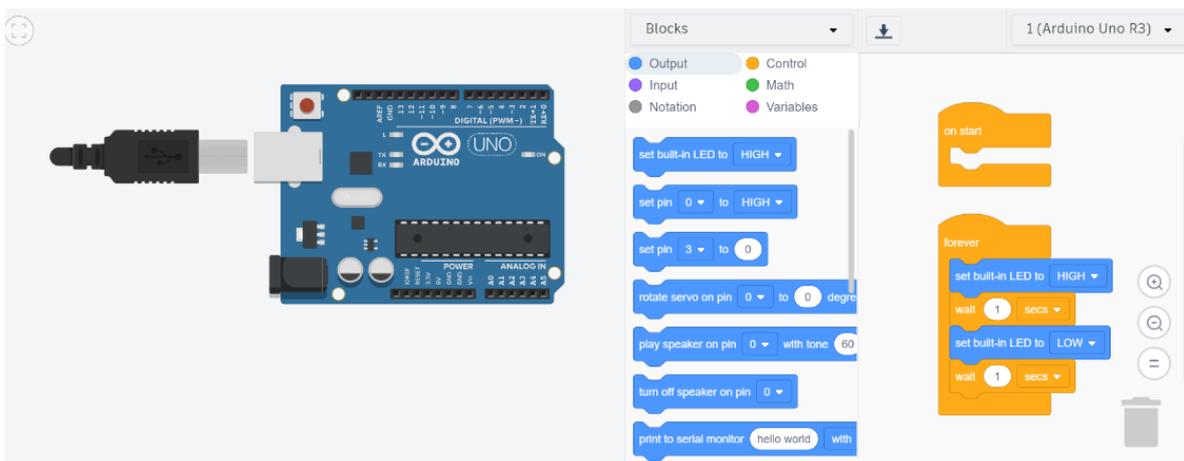
### If Using the Arduino Uno board

1. Open the Arduino IDE software on your computer. Make sure the Arduino is plugged into the USB port.
2. Under File-->Examples-->01. Basics open Blink example.
3. This is an example code that allows you to blink an LED on the Arduino.
4. Read through the code on the page. Be aware that any text marked with a // indicates a comment from the developer. These comments tell you what the code does.
5. Select the Uno board from the drop-down menu at the top of the screen.

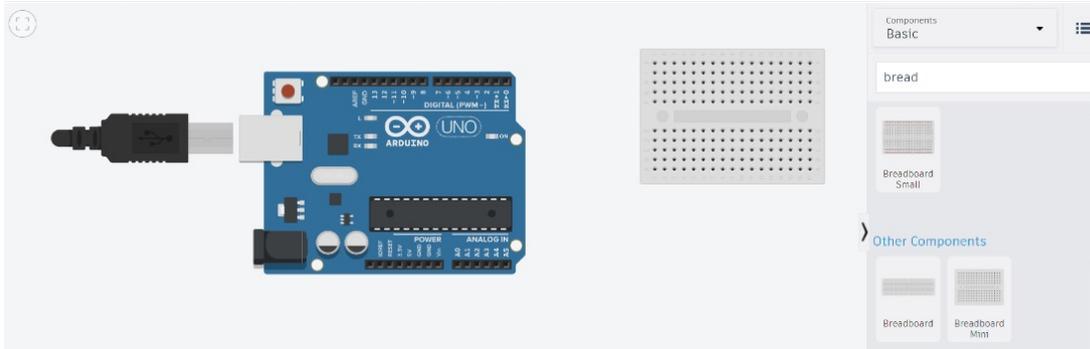
6. Run the debugger. There should be no errors.
7. Upload the program to the Arduino board.
8. Change the delay from 1000 to 4000.
9. Run the debugger. There should be no errors.
10. Upload the program to the Arduino board.
11. Make observations about what happened to the LED.

### If No Arduino Uno Board

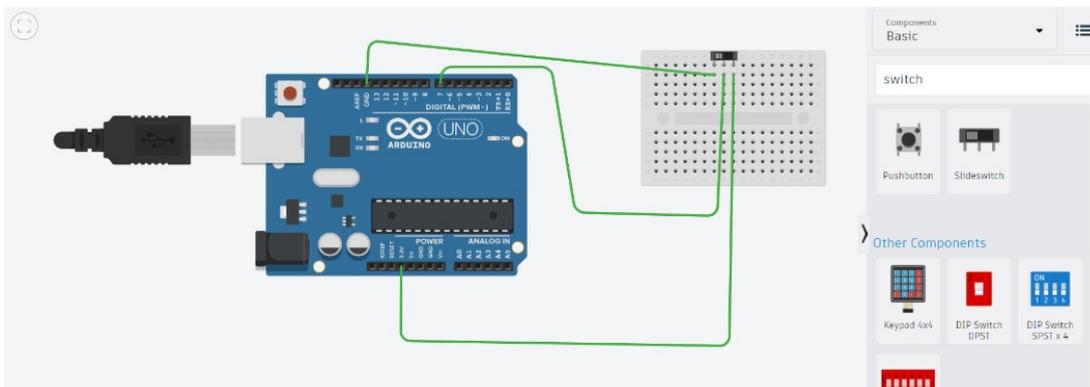
1. Open the Arduino IDE software on your computer. There will be no Arduino connected.
2. Under File-->Examples-->01. Basics open Blink example.
3. This is an example code that allows you to blink an LED on the Arduino.
4. Read through the code on the page. Be aware that any text marked with a // indicates a comment from the developer. These comments tell you what the code does.
5. Make observations about what you read in the code.
6. Now, you are going to program an Arduino in Tinkercad using block code.
7. Open Tinkercad and start a new project.
8. Search for Arduino Uno in the search for components bar.
9. Drag the Arduino into the window.
10. Select the button that says “code”; this should open the following window.



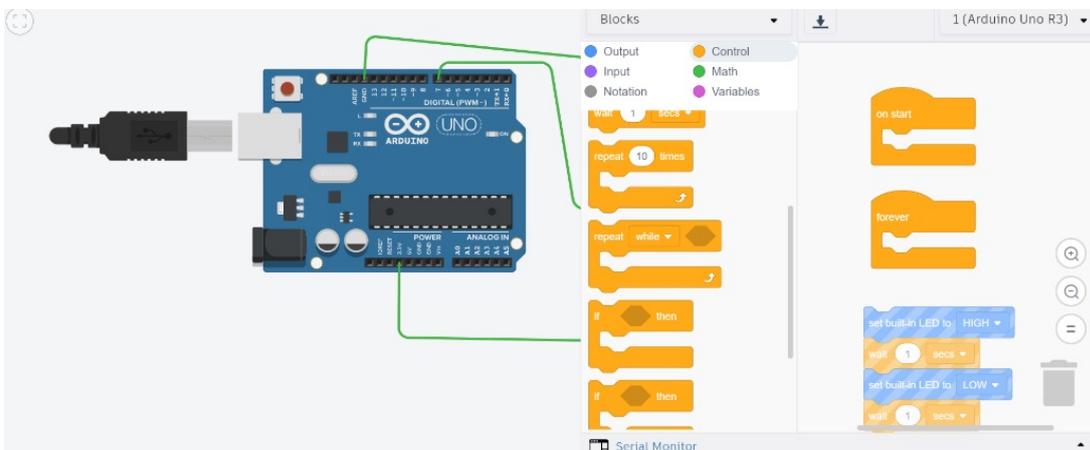
11. Note that this is a block code. Select “run simulation.” You should see the light L begin to blink.
12. Close the code window by selecting the button again, and search for a breadboard. Place a mini breadboard into the window.



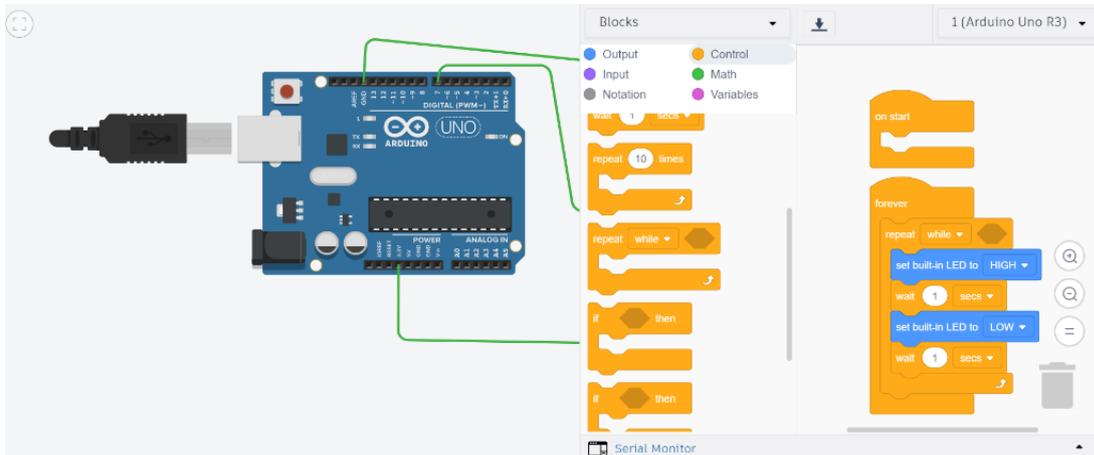
- Search for a switch and place a slide switch in the window. Then, connect it as shown in the diagram.



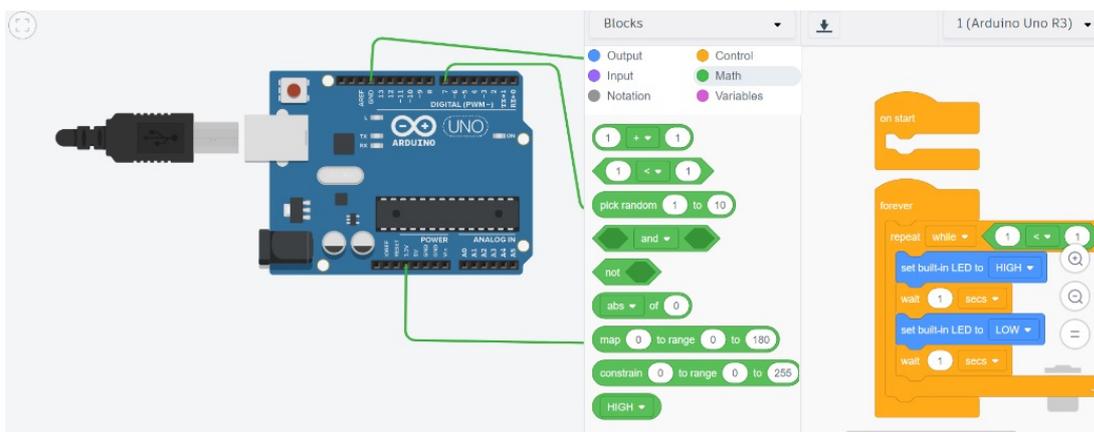
- Open the code again; this time, go to the tab labeled "Control." Then, pull the blocks inside of the block labeled "forever" out of the block. Your window should look like this:



- Insert a "repeat while blank" block into the "forever" block. Then, place the original contents inside the "repeat while" block so that your window now looks like this:



- Now, open the “Math” tab and insert a less-than block so that the window now looks like this:



- Open the “Input” tab and insert a “read digital pin” in the farthest bubble. Set the digital pin to pin 7, which is the pin that should be connected to the image of the board. Make the value of 1 a 0. Your window should now look like this:
- Close the code blocks and run the simulation. Make observations about what is happening.
- Select the slide switch.
- Make observations about what happened.
- Close the browser windows and the Arduino IDE.

### Questions to Ask After the Activity

- What did you learn about how microchips are coded?
- Was there anything that you found fun about the activity or that you would like to know more about?

3. What happened when you added an input to the blinking LED? Could you turn it on and off externally?

### **Thinking About Your Future**

Talk to students about what interested them about this activity. Explain that there are quite a few semiconductor professionals who interact with microchips in this way. Electrical Engineers design the circuits and code the microchips to interact with them. Computer Engineers design the microchips and program them for tasks. Computer Scientists write the code that controls the microchip and may create new code to allow the microchip to read information and communicate with other devices.

### **Additional Resources for Further Interest**

If students have further interest in this topic, there are many resources that can help. A few are listed here:

- Arduino educational resources for K-12: [Arduino education](#)
- Semi.org Micro:bit educational resources [here](#)
- Circuit Scribe educational resources [here](#)
- Semi.org educational resources [here](#)

### **Activity 2:** PhET Simulation Activity



#### **Materials**

- Computer
- Working internet connection



#### **Prep Before the Lesson**

Before beginning the activity, familiarize yourself with the PhET simulation at [PhET simulation](#). The PhET simulation allows students to explore doping semiconductors and the blocking behavior of diodes based on which type of doped semiconductor is connected to the positive and negative terminals of a battery.



## Vocabulary

1. **Diode:** A semiconductor device designed to conduct current in only one direction for specified voltage and current values. Are you familiar with leakproof ketchup bottles? To get the contents out, turn the bottle upside down and squeeze. To stop the flow, stop squeezing. These bottles use a one-way valve. Diodes work the same way!
2. **Junction:** The boundary between different semiconductor types in a transistor. A junction is like a fence between a house and a neighbor. A gate must be built into the fence for people to pass through.
3. **Doping:** The act of introducing impurities to a semiconductor device in order to produce the desired electrical behavior. Like adding baking powder to a cake turns flour and sugar into a cake, adding impurities to silicon makes it a semiconductor.
4. **N-Type:** A negative-type semiconductor is doped with impurities that add free electrons. N-type semiconductors are like friends who have extra cookies to give away. The electrons, like the cookies, can be passed to a device that has none.
5. **P-Type:** A positive-type semiconductor is one in which the doped materials leave electron “holes,” yielding a positive charge in the semiconductor. Positive-type semiconductors are like the friends who would like an extra cookie and are ready to be connected to their N-type friends who have cookies to give away.



## Questions to Ask Before the Activity

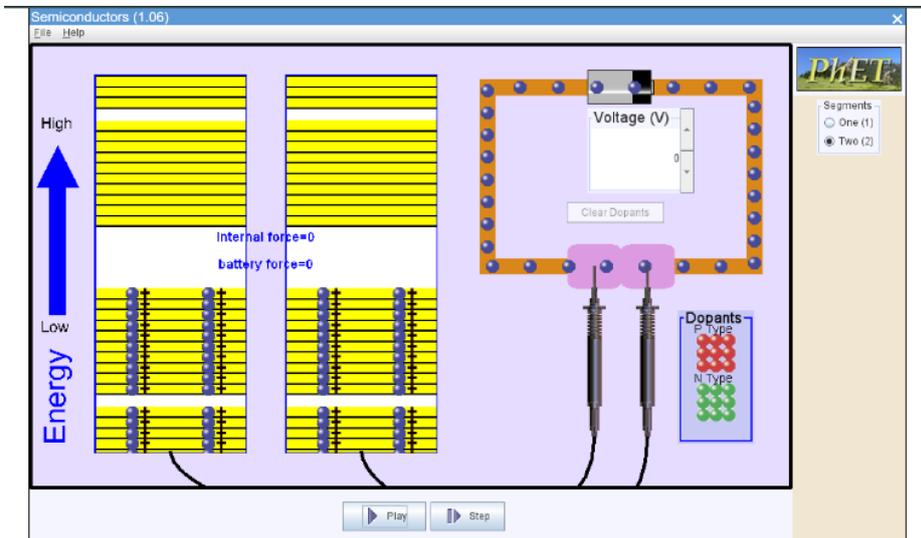
1. What do you think might happen when you put a P-type and an N-type semiconductor together and connect them to a battery?
2. What do you think will happen when you connect the P-type semiconductor to the negative terminal of the battery and the N-type to the positive terminal?
3. What do you think will happen when you connect the N-type semiconductor to the negative terminal of the battery and the P-type semiconductor to the positive terminal?



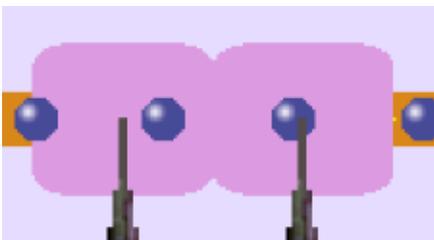
## Procedure

1. Have students open the PHeT simulation on their computer.

- On their screen should be a window that looks like this

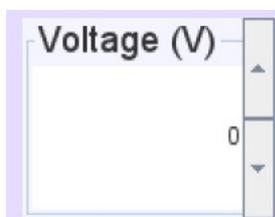


- On the picture of the battery and semiconductor to the right are two electrodes connected to pink boxes. The electrodes are connected to the model of the inside of the battery to the left. The two pink boxes look like this:



The dopants will be placed in these boxes to create the simulated diode.

- Students will increase the battery voltage from 0 to 1 V with no dopants in the pink boxes using the arrows on the box with the word “voltage” in it.



- Have students connect a P-type semiconductor to the negative terminal of the battery (the silver side of the battery), and an N-type semiconductor to the positive terminal of the battery (the black side of the battery).
- Have students press the play button at the bottom of the screen and watch the simulation for a few moments.
- Ask students what they are seeing. Are the electrons (the blue dots in the picture) moving? What is happening inside the battery (shown on the left)?

8. Have students pause the simulation and select the “clear dopants” button.
9. Now, have students connect the N-type semiconductor to the negative terminal of the battery (the silver side) and a P-type semiconductor to the positive terminal of the battery (the black side).
10. Have students press the play button at the bottom of the screen and watch the simulation for a few moments.
11. Ask students what they are seeing. What is happening to the electrons (the blue dots)? What is happening inside the battery?
12. Have students clear their simulation and close the browser window.



### **Questions to Ask After the Activity**

1. What happened when the P-type semiconductor was connected to the negative terminal of the battery?
2. What happened when the N-type semiconductor was connected to the negative terminal of the battery?
3. Did the electrons stop moving in either of the two cases? If they did, did they stop right away, or did it take a few moments?
4. What do you think this activity shows you about how a diode works? Explain in your own words what a diode is.



### **Thinking About Your Future**

Students just explored what happens when you use different types of semiconductors to create a desired behavior in an electric circuit. Ask students about what interested them in this activity. Explain to students that there are many career paths in the semiconductor industry. This activity helps them visualize the operation of diodes. Many kinds of careers work with diodes: Electrical Engineers, Chemical Engineers, Materials Scientists, Chemists, Physicists, Technicians, and Electricians. Electrical Engineers design circuits using circuit elements like diodes to obtain desired outcomes. Chemical Engineers, Materials Scientists, Chemists, and Physicists help design better materials to create more effective diodes and other semiconductor devices. Technicians and Electricians use semiconductor devices to build and test the designs that are developed by Electrical Engineers.

### Activity 3: Semiconductor Bracelet Activity



#### Materials

##### Day 1

- Cardboard
- Popsicle sticks
- Hot glue
- Hot glue gun
- Aluminum wire for crafting (can be purchased from [Amazon](#) for 12.99 for a 100-ft roll)
- Fabric
- Washable school glue
- Parchment paper
- 8 × 8-in. small squares of parchment paper
- Paper plates (two per student)
- Scissors
- Paper towels and wet wipes

##### Day 3

- Puff paints in various colors (can purchase 12 colors for 8.97 [here](#))
- Paper towels
- Hot glue
- Hot glue gun
- Paintbrushes



#### Prep Before the Lesson

##### Day 1

1. Cut the lengths of aluminum wire. Make sure they are the same length. These wires will be used as the arms to wrap the bracelet around your student's wrists, so size them accordingly.
2. Set up hot glue gun stations if using them instead of giving each student a hot glue gun.
3. Cut large squares from cardboard (about 1 in. × 1 in.), and adjust the size based on the average wrist size of your students.
4. Cut smaller squares from the cardboard (about 0.5 in. × 0.5 in.); if the cardboard

- squares in Step 2 are smaller than 1 in., make them a bit smaller.
5. Cut thin strips of cardboard about 1 in. long by about 0.25 in. thick.
  6. Cut fabric into thin strips about 1 in. wide and about 2–3 in. long. You want to be able to wrap it completely around the large cardboard squares at least three times.
  7. Cut another set of fabric strips, smaller than those in Step 6, long enough to wrap over and around the widest part of the thin strips of cardboard made in Step 5 to completely cover the cardboard.
  8. Make a stack of paper plates with an 8 × 8-in. square of parchment on each paper plate to be ready for Step 12.

### Day 3

1. Set up hot glue gun stations for students.
2. Check to make sure that the bracelets are dry.



### Vocabulary

1. **Wafer:** Thin and round sheet cut from an ingot made from a material used in creating semiconductors (like silicon or gallium). Imagine slicing a sausage into rounds. The sausage is the ingot, and the wafer is the rounds.
2. **Die:** A single semiconductor cut from a wafer ready to be bonded to a frame.
3. **Frame:** The base to which a semiconductor is attached. The frame typically has “leads” through which the semiconductor can communicate with the outside world.
4. **Wire Bonding:** The process by which wires connect the semiconductor to the leads on the frame.
5. **Packaging:** The step in manufacturing a semiconductor when a die and frame are embedded or potted in a plastic-type material that protects the semiconductor device from outside contaminants.



### Questions to Ask Before the Activity

1. What do you think it takes to finish making a semiconductor device from a finished wafer?
2. What did you learn about the steps of making a microcontroller in Lesson 4: A Beginner's Guide to Back End Assembly and Functions?

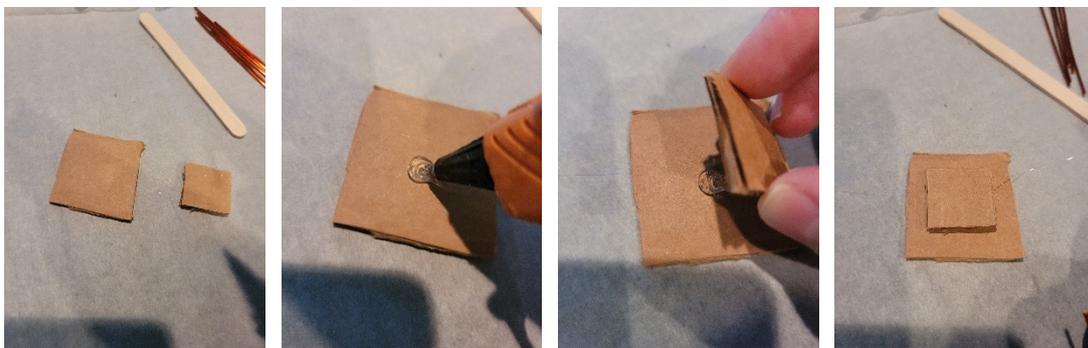
 **Procedure**

1. Prepare for each student a length of parchment paper to cover their desk, a low-temperature hot glue gun, hot glue (or set up a hot glue station), six precut wires, a large cardboard square, a small cardboard square, two cardboard strips, one large piece of precut fabric, two small pieces of precut fabric, a paper plate with a large puddle of glue, and a popsicle stick.

Explain that today they are going to perform the steps for packaging their own semiconductor just like the back end assembly process reviewed in the lesson. The pictures will provide clarification if needed.

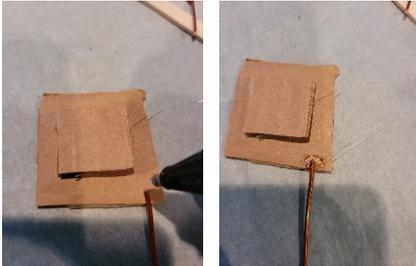


2. To begin with, have students bond the small cardboard square to the large cardboard square with hot glue. Explain that this is the same as the die attachment step in semiconductor back end assembly when the die is attached to the frame. Follow the pictures if you need clarification.

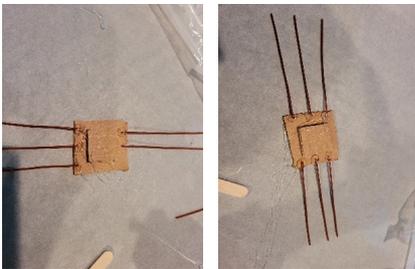


3. Next, have the students carefully glue the wires one at a time to the cardboard base. Have them set the wire on the cardboard, and then carefully bring the hot glue gun in contact with the wire while gently squeezing the trigger and lifting the hot glue gun. This will bond the wire to the cardboard. Explain that this is

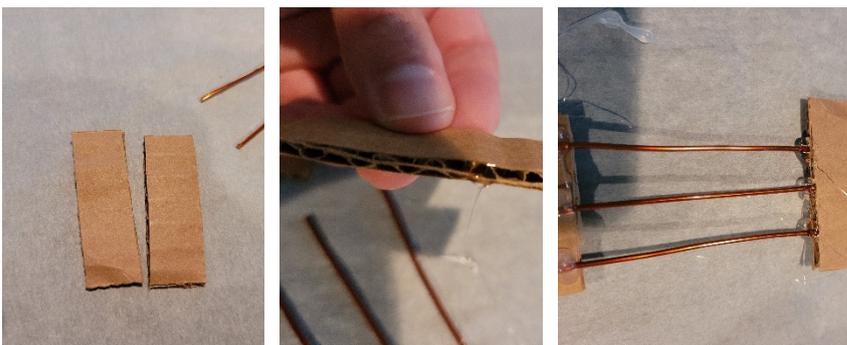
the same as the wire bonding step, when the wires are connected between the semiconductor die and the frame. Follow the pictures if you need clarification.



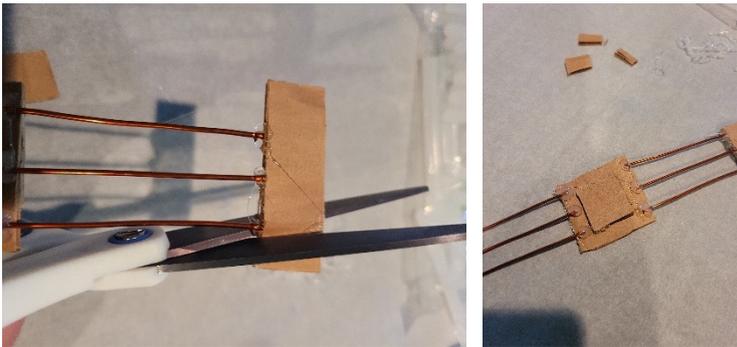
4. Have students repeat Step 3 on the first side of the square, and then repeat it on the opposite side of the square. This will become the arms of the semiconductor bracelet. Explain that they are using a similar process to bonding wires using a soldering iron, but without the solder. In this case, the melted glue is like the solder that will be used to bond real wires to a semiconductor die and frame. Follow the pictures if you need clarification.



5. Once the hot glue has cooled, slide the three wires on one side of the square into the cardboard strip. It can be helpful to add a dot of hot glue in one of the corrugated holes to hold one of the wires so that it doesn't move around. Then, fill the rest of the holes on either side with hot glue. Explain that this is not a step in the manufacturing process but is necessary to make this into a bracelet. Follow the pictures if you need clarification.



6. If necessary, have students cut the cardboard strip down in length so that it is the same size as the wires. The final product should look like the second image shown below. Explain that this is another step that is necessary to make this a comfortable bracelet but is not part of the manufacturing steps. Follow the pictures if you need clarification.



7. Have them inspect their work, making sure that all the wires are properly connected, and nothing is loose. This is the same as the inspection sorting step in the manufacturing process. If they do not inspect their bracelets and fix anything that went wrong, their bracelet may come apart.
8. Next, have students place their large fabric strip in the school glue on the plate. Tell them to use a popsicle stick to coat the fabric completely in glue. Explain that these next steps are like the packaging step in the back end assembly process. In this case, however, we are using fabric to create the packaging because it is easier to do in class. In a real semiconductor fab, the packaging will be created by either making a plastic case that snaps onto the semiconductor with a piece of machinery or by placing the semiconductor in a mold and pouring resin over the semiconductor. Follow the pictures if you need clarification

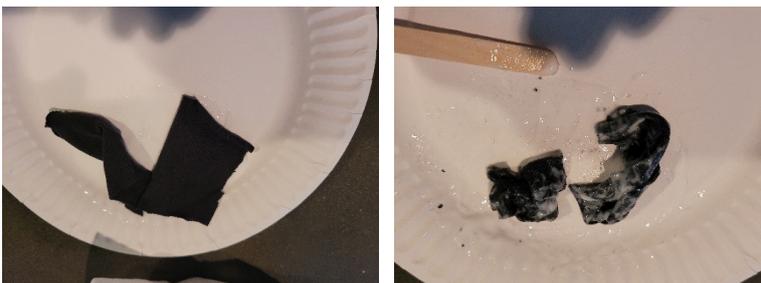


9. Have students carefully take the fabric out of the glue, squeeze off the excess,

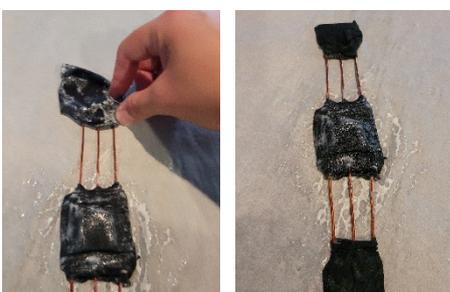
and then wrap the fabric tightly around the cardboard. They should work to smooth out any wrinkles and pull the fabric tight so that the small square and large square are visible through the fabric. Use the popsicle stick or fingers to smooth out the glue and remove any excess. Explain that they have now completed the packaging step of making their semiconductor. Follow the pictures if you need clarification. If students need them, use paper towels and wet wipes to clean up after this step.



- If necessary, add more glue to the plate before soaking the last two pieces of fabric in the glue. Explain that this fabric is not part of the packaging process but is being used to make their bracelet more comfortable and durable. The fabric should be soaked in the same way as in Step 8.



- Have students squeeze excess glue out of the fabric strips and wrap each of the small cardboard strips at the ends of the bracelet. Make sure to smooth out excess glue and make the bottom of the strips smooth. Keep the bracelet on top of the parchment paper.



12. Give each student an 8 × 8-in. square of parchment paper and a clean paper plate. Make sure that the student's name is written on the small square of parchment paper, and on a clean paper plate. Then, have students set their bracelets on top of the small square of parchment paper, set the paper on the plate, and move it to a safe place where they can dry. Drying time can take up to 2 days to complete.
13. When the bracelets are dry, students will perform the final step, which is the package marking and final testing step. Explain that they will now put their own marking on their semiconductor and test to make sure that everything is properly connected. Have them pull on their wires and the other parts of their bracelet. Nothing should move or wiggle. If it does, perform repairs. If not, their bracelet is ready to be marked. Give students puff paints and paint brushes to decorate the top of their semiconductors. Paper towels and wet wipes may be necessary for cleanup. Explain that semiconductor manufacturers mark their semiconductors so that manufacturers and end users will know who manufactured the semiconductor and any other important information about the semiconductor.



### **Questions to Ask After the Activity**

1. Was there any part of the process that you found fun or interesting? Have students discuss.
2. Why was it important to test your bracelet in Step 7 and Step 13? What might have happened if you did not test your bracelet?
3. Now that you have done your own process for packaging a semiconductor, what do you think it is like to work in a real semiconductor manufacturing facility?



### **Thinking About Your Future**

Students just explored the semiconductor back end assembly process by performing their own mock-up of that process by making a semiconductor bracelet. Ask students about what interested them in this activity. Explain to students that there are many career paths in the semiconductor industry. This activity helps them explore and experience some of the steps in the back end assembly process. Many kinds of careers work in this process: Electrical Engineers, Chemical Engineers, Materials Scientists, Technicians, Mechanical Engineers, CAD Technicians, Mechanics, and Electricians.

Electrical Engineers design and test the semiconductor devices and the electrical connections for the semiconductor. Chemical Engineers, Materials Scientists, and Chemists help design better materials for potting and packaging new semiconductors. Technicians work on the machinery and perform quality checks to make sure that the new semiconductors work the way they are supposed to. CAD Technicians develop computer models of designs for new semiconductor packages. Electricians and Mechanics work on the machinery that performs the back end assembly process.