

**Description:**

Technology is rapidly evolving and is becoming more integrated into our everyday lives. It is used in many ways to work smarter, not harder. However, technology is helpful to a certain degree -- it is useful when it is utilized properly and optimally. Hence, the more we learn about technology, the more use we can get out of it. Our goal is to understand and be able to enhanced the Arduino code that is used to program our SeaGlide. In this unit, we are going to begin learning about the basics of block LEDES and buttons coding. This lesson is adapted from [LEDs, Resistors & Buttons](#) provided by the U.S. Navy's SeaGlide DropBox.

**Students will be able to:**

- Use and code LEDs in Arduino with both single and multiple LEDs
- Use push buttons
- Define global and local variables

**Students will understand:**

Students will understand how LEDs are used, wired, and coded in an Arduino board. After learning the basics of LEDs, they will learn how make them function using push buttons and NO switches. Students will be able to discuss how else these switches can be used, however. Through learning about NO switches, students will come to understand pull-up and pull-down resistors and how they can be used. Students will also come to understand global and local variables and how they are used in more complex loops.

**Key Definitions & Concepts [1]:**

- **LED** (Light-Emitting Diode) - a semiconductor device that emits visible light when an electric current passes through it.
- **Normally Open (NO) Push Buttons** (also called momentary switches): electrically disconnects a circuit unless pressed. This type of switch only conducts electricity while pressed.
- **Pull-Up Resistor:** a highly restrictive path to +5V that pulls the input to HIGH when the lower-resistance path to ground (through the button) is not connected.
- **Pull-Down Resistor:** a highly restrictive path to ground (0V).
- **Floating Voltage:** often an unintentional electrical potential that comes from previous circuit activity or environmental static electricity, which can trigger false inputs.
- **Global Variables:** are defined at the beginning so that they can be accessed in any part of the program.
- **Local Variables:** stay within the function that they are created.

**Standards [Copied from: 2]:**

3A.CS.03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

3A.AP.15 Justify the selection of specific control structures when tradeoffs involve implementation, readability, and program performance, and explain the benefits and drawbacks of choices made.

	Background Information	
--	------------------------	--

**Prior Knowledge:**

- Prior Python lessons
- Prior Circuit lessons

<p><b><u>Science Practices [Copied from: 3]:</u></b></p> <ul style="list-style-type: none"> <li>● Constructing Explanations and Designing Solutions</li> <li>● Using Mathematics and Computational Thinking</li> </ul>	<p><b><u>Core Ideas [Copied from: 4]:</u></b></p> <ul style="list-style-type: none"> <li>● Defining and Delimiting Engineering Problems</li> <li>● Developing Possible Solutions</li> <li>● Optimizing the Design Solution</li> </ul>	<p><b><u>Cross Cutting Concepts Copied from: 5]:</u></b></p> <ul style="list-style-type: none"> <li>● Structure and Function</li> <li>● Systems and System Models</li> <li>● Cause and Effect</li> </ul>
--	---	--

**Possible Preconceptions/Misconceptions:**

Students coming into the lesson may assume that coding in arduino is just like python. While the coding languages are similar and while the basic computer science concepts are the same, there are still differences between these coding languages. Students will get to work with this new coding language by building off of prior knowledge and by utilizing a given stock Arduino code. This allows students to more easily draw connections between Arduino and python while fostering the learning of Arduino syntax.

	Lesson Plan - 5E(+) Model	
--	---------------------------	--

**Engage: Lesson #1: LED & Push Button [1]**

Students should complete the *Circuits Review* worksheet in pairs. This allows student to recall important and applicable information about circuits (learned in the Electrical Circuits module) before wiring an arduino board. After students complete the review, the teacher should go over the worksheet as a class. It is important to make sure that everyone in the class understands and is on the same page. Otherwise, they may struggle moving forward with setting up the arduino board properly. The instructor should allow for students to work in their pairs for up to 5 minutes, then expect to hold a 5 minute discussion to review students' responses and address any misconceptions as necessary. Hence, this section should take 10 minutes to complete.

**Engage: Lesson #2: Traffic Light [1]**

Students should complete the *Review Quiz* individually. This allows students to recall what they learned from the prior day. It is imperative that students remember what they did the previous day in order for them to be successful in the traffic light activity. After the teacher collects the quizzes, he/she

should review the answers with the class and any misconceptions as necessary. Students should be given 5 minutes to work on the quiz, and the discussion should last up to 5 minutes after collection. Hence, this section should take 10 minutes to complete.

### **Explore: Lesson #1: LED & Push Button [1]**

#### **Part I: Introduction**

Students will work in pairs to complete the activities *LED Blink* section of the Arduino Unit 1 packet provided by SeaGlide, [LEDs, Resistors & Buttons](#). Reference the *Teacher Notes* attachment for materials lists and other information for this unit plan. Also, reference the *Instructor's Guide* to see how the packet should be read aloud while including stopping points for questioning, activities and explanations.

Through this portion of the lesson, students will have to wire their own circuit board and connect it to the computer via the HDMI port of the computer to the mini USB of the Arduino. Students will learn how to use resistors and apply their knowledge from previous circuits lessons. Students are given a base code to work with to get the LED to light up and blink. From there, students will need to edit the code on their own to complete certain tasks, such as changing the frequency of the blinking LED. Students will need to address they changed what in the code, why it was changed, and if the new code worked. If it does not work, students will troubleshoot and try to fix their code. This should take 25 minutes.

#### **Part II: Benchmark Lesson: Push Button**

Students will work in pairs to complete the activities *LED Push Button* section of the Arduino Unit 1 packet provided by SeaGlide, [LEDs, Resistors & Buttons](#). Reference the *Teacher Notes* attachment for materials lists and other information for this unit plan. Also, reference the *Instructor's Guide* to see how the packet should be read aloud while including stopping points for questioning, activities and explanations.

Through this portion of the lesson, students will learn what pull-up and pull-down resistors are and how they can be used to prevent floating voltages without using switches. Push buttons are a type of NO switch and students will use this new learned information in the activity to see how this affects the LEDs. Students are once again given a base code that they will have to edit and troubleshoot problems with. Students will be able to explore the effects of pull-up and pull down resistors on NO switches. This should take 25 minutes.

### **Explore: Lesson #2: Traffic Light [6]**

#### **Part III: Investigation Lesson: Traffic Light**

Students will first watch the video [Global and Local Variables in Arduino](#) and fill out the *Global and Local Variables* half-sheet individually. An understanding of global and local variables is important for the following activity, so instructors should expect to hold a brief discussion to review students responses and address any misconceptions as necessary. This will take 10 minutes to complete.

Students will then work in pairs to complete the *Traffic Light* section of the Arduino Unit 1 packet provided by SeaGlide, [LEDs, Resistors & Buttons](#). Reference the *Teacher Notes* attachment for materials lists and other information for this unit plan. Also, reference the *Instructor's Guide* to see how

the packet should be read aloud while including stopping points for questioning, activities and explanations.

Like the previous activities a base code is given for students to start with in completing the activity. Students will follow the steps to then make three different LEDs blink like a traffic light. The code requires a while loop which students will need to recall from the previous python lessons. Students will need to be able to apply global and local variables in their code. This should take 35 minutes.

**Explain:**

Throughout the exploration, the students will engage in discussions that inquire their understanding and knowledge of the information at-hand. Teachers should also be informally asking students to explain all topics and relevant connections throughout the entirety of this lesson when circulating the classroom. The worksheets include questions where students must explain their reasoning and troubleshoot. This gives the students an opportunity to verbalize their understandings.

**Elaborate:**

Coding is a very useful and real-world skill that all modern technology relies on. Students will have the chance to see how LEDs, something that is common in their everyday lives, are affected. Students will also explore how traffic lights are coded and how coding affects things that they may tend to neglect or not think about.

**Evaluate:**

Students are evaluated both informally and formally throughout the entirety of this lesson. The informal evaluations occur during the open class discussions. When the teacher is circulating the classroom, he/she is able to check for surface level understanding and make sure that the class is all on the same page by listening to students' discussions and responses. The instructor can gauge students' progress through observing whether or not they are struggling to complete the activities. The formal assessments of this lesson are the culmination of all the worksheets and review quizzes as well as whether or not the code runs properly. It is strongly recommended to instruct the students to return all documents used during each lesson for grading.

**Enrich:**

This lesson can be extended into a linear algebra classroom. Linear algebra is used to assess traffic patterns and determine how traffic lights should be timed. An activity can be done in assessing traffic patterns and deciding how the light should be coded to run. Creating equations for how fast traffic backs up in a specific direction, based on flow, can also be used to solve the optimum solution to timing traffic lights. Hence, this is an excellent introductory lesson to a college level linear algebra class.

**\*\*All associated documents are attached below\*\***

**\*\*Reference *Annotated Bibliography* on the very last page of this packet\*\***

# Lesson #1: LED & Push Button Worksheets

## Teacher Notes for Reference Day 1 [7]

Use the [SIK Guide](#) to access the following: (including pictures and diagrams)

- Downloading and accessing Arduino pages 4-9
- Materials list and inventory pages 12-13
- Build Guide LED Blink page 19-24

NOTE: Other examples are provided in this reference involving sensors, but they are not the same as those provided by [LEDs, Resistors & Buttons](#) from the U.S. Navy's SeaGlide DropBox.

## Instructor's Guide Day 1:

### **Explore: Lesson #1: LED & Push Button [1]**

#### Part I: Introduction

Starting on page 6 have student read aloud the first two paragraphs of part *1.1 Blink*. Stop and ask the class questions such as:

- “How does this relate to the circuits unit we already completed?”
  - Answer goal: Students should discuss that they already learned ohm's law; they use resistors in wiring circuits
- “What else do we know or remember about resistors?”
  - Answer goal: The resistance relates to voltage and current; resistors resist current flow of electrons

Then have the students work in pairs to complete the first exercise on page 7.

Next, have students read aloud pages 7 and 8 up until where the code starts. Then, have the students work in pairs to set up their Arduino boards and connect them to the computer using those pages in the packet as a reference.

Once students have their set up instruct, them to upload or copy & paste the code provided to their boards. Once the code has been inputted, have a student read aloud the first paragraph on page 9. Then, have the pairs follow the instructions in the first paragraph on page 9 to make sure their boards are functioning properly and complete the exercise on page 9.

#### Part II: *Benchmark Lesson*: Push Button

Have students read aloud from page 9 through page 10, starting with 1.2 Button and stopping just before the exercise. Ask students questions such as:

- “What are some practical uses of NO switches?”
  - Answer goal: light switch, etc.
- “What is a floating voltage?”
  - Answer goal: Unintentional electric potential that trigger false inputs
- “What do you remember about conditional statements from python?”
  - Answer goal: If-else statements are used in python; based on the input, there can be different outcomes

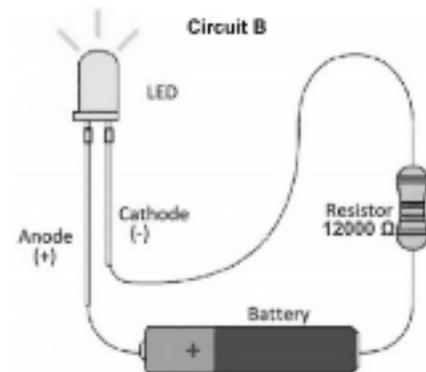
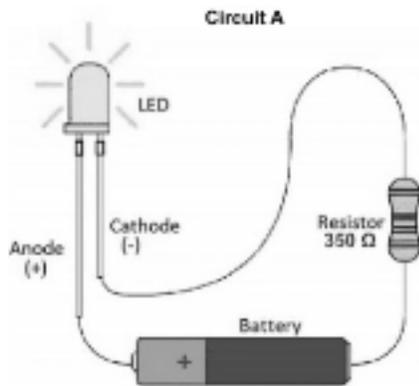
Then, instruct students to work in pairs to upload the code written on the top of page 11 and to complete the exercise on the bottom of page 10. Once they finish this, have them complete the exercise on page 11.

**Note:** If time permits or if some pairs are ahead of others, they can be challenged by translating the Arduino code (from pages 8 and 11) to run in Python. This would be a great introductory activity since the final unit plan of this module incorporates Python and Arduino together.

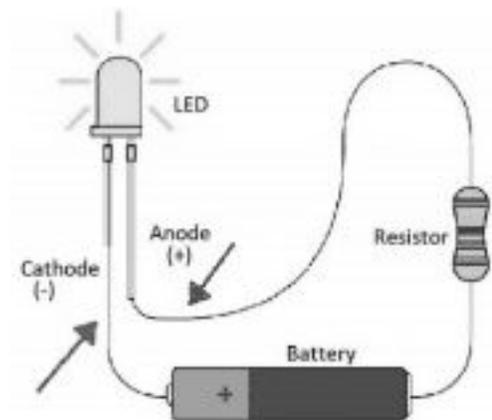
Name: \_\_\_\_\_ Date: \_\_\_\_\_

### Circuits Review [1]

1. What is a resistor?
2. Pictured below are two simple circuits consisting of an LED, a battery, and a resistor. Circuit A contains a  $350\Omega$  resistor and circuit B contains a  $12000\Omega$  resistor. Explain why the LED on one of the circuits is dimmer than the other. What does that tell you about the relationship between resistance and current?



3. Comparing the circuit below to the circuit in *Question 2*, explain what could happen if the anode of the LED was connected to the negative side of the battery and the cathode was connect to the positive side. Support your response.



# Lesson #2: Traffic Light Worksheets

## Teacher Notes for Reference Day 1 [7]

Use the [SIK Guide](#) to access the following: (including pictures and diagrams)

- Downloading and accessing Arduino pages 4-9
- Materials list and inventory pages 12-13

NOTE: Examples are provided in this reference involving push buttons, but they are not the same as those provided by [LEDs, Resistors & Buttons](#) from the U.S. Navy's SeaGlide DropBox. This can be seen on pages 37-40

## Instructor's Guide Day 2:

### **Explore: Lesson #2: Traffic Light [1]**

#### Part III: Investigation Lesson: Traffic Light

After students complete the Global and Local Variables, have them read aloud section 1.3 Traffic light aloud starting on page 11. Give the students a few minutes to look over the code on page 13 themselves, then ask them to explain what they are reading, i.e. "what is happening in this code?". Then have another student read aloud the paragraph on the bottom of page 13. Stop and ask students:

- "How and why are while loops used?"
  - Answer goal: They are used when we need a certain logic to be met. They run continuously until this happens. Students may also make connections to python.

Have students work in pairs to upload the code provided to their board and to complete the exercise on page 13.

**Note:** If time permits, have students translate the Arduino code into Python. This would be a great introductory activity since the final unit plan of this module incorporates Python and Arduino together.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

### Review Quiz [1]

What is an LED?

What is a diode?

What is a NO push button?

What are pull-up versus pull-down resistors?

Name: \_\_\_\_\_ Date: \_\_\_\_\_

### Global and Local Variables [6]

Watch the [Global and Local Variables in Arduino](#) video and answer the following questions:

Describe what a global variable is and how it is used.

Describe what a local variable is and how it is used.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

### Global and Local Variables [6]

Watch the [Global and Local Variables in Arduino](#) video and answer the following questions:

Describe what a global variable is and how it is used.

Describe what a local variable is and how it is used.

# Lesson #1: LED & Push Button Answer Keys

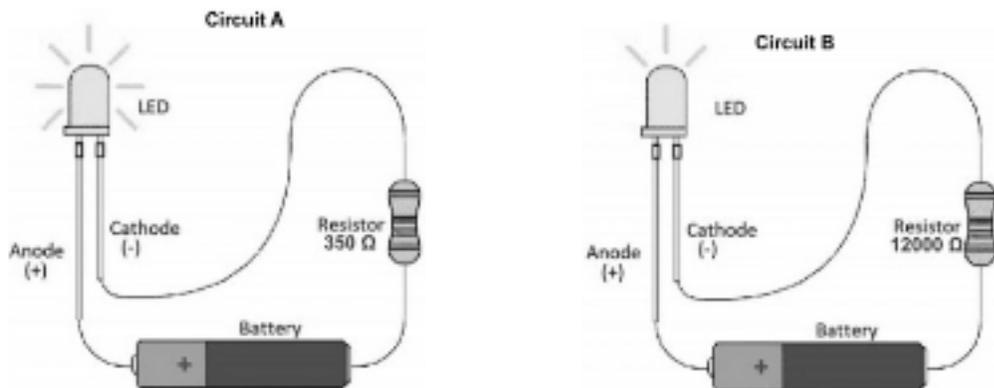
Name: \_\_\_\_\_ ANSWER KEY \_\_\_\_\_ Date: \_\_\_\_\_

### Circuits Review [1]

1. What is a resistor?

An electrical component that resists the flow of electricity.

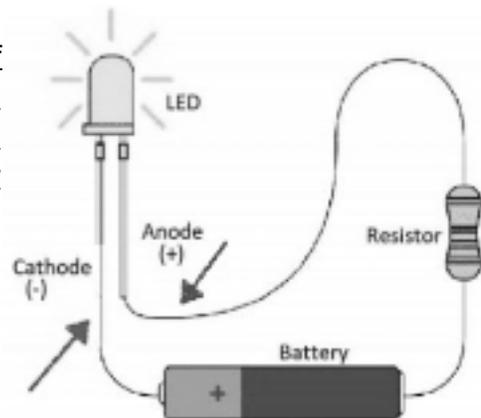
2. Pictured below are two simple circuits consisting of an LED, a battery, and a resistor. Circuit A contains a  $350\Omega$  resistor and circuit B contains a  $12000\Omega$  resistor. Explain why the LED on one of the circuits is dimmer than the other. What does that tell you about the relationship between resistance and current?



The LED in circuit B is dimmer than the LED in circuit A because of the resistor. The resistor on circuit B has a higher resistance than the resistor on circuit A. This allows the LED bulb on circuit A to light brighter than the LED in circuit B. This tells us that the relationship between resistance and current is inverse. A higher resistance allows less current to flow and lower resistance allows more current to flow.

3. Comparing the circuit below to the circuit in *Question 2*, explain what could happen if the anode of the LED was connected to the negative side of the battery and the cathode was connected to the positive side. Support your response.

If the anode was connected to the negative side of the battery and the cathode was connected to the positive side, the circuit could become damaged because an LED is a diode and diodes allow current to flow in one direction.



Lesson #2: Traffic Light  
Answer Keys

Name: \_\_\_\_\_ ANSWER KEY \_\_\_\_\_ Date: \_\_\_\_\_

### Review Quiz [1]

What is an LED?

An LED is a light emitting diode.

What is a diode?

A semiconductor device that emits visible light when an electric current passes through it.

What is a NO push button?

It electrically disconnects a circuit unless pressed. This type of switch only conducts electricity while pressed.

What are pull-up versus pull-down resistors?

Pull-Up Resistor: a highly restrictive path to +5V that pulls the input to HIGH when the lower-resistance path to ground (through the button) is not connected.

Pull-Down Resistor: a highly restrictive path to ground (0V).

Name: \_\_\_\_\_ ANSWER KEY \_\_\_\_\_ Date: \_\_\_\_\_

### Global and Local Variables [6]

Watch the [Global and Local Variables in Arduino](#) video and answer the following questions:

Describe what a global variable is and how it is used.

A global variable is defined for the entire code and can be used throughout the all of the code.

Describe what a local variable is and how it is used.

A local variable is defined in the loop and can only be used in the loop.

## Annotated Bibliography

- [1] SeaGlide. (n.d.). Retrieved from <http://seaglide.org/>  
This lesson plan was used for excerption within the Arduino Unit 1:LEDs, Resistors, Buttons unit plan. This referenced is used in completion of the explore in this unit.
- [2] Standards Aligned System. (n.d.). Retrieved from <https://www.pdesas.org/>  
This website was used in each lesson in the Arduino modules to select proper Pennsylvania State standards, which are based in Common Core, that each lesson is centered around.
- [3] Nsta. (n.d.). Access the Next Generation Science Standards by Topic. Retrieved from <https://ngss.nsta.org/AccessStandardsByTopic.aspx>  
This website used in every lesson in the Arduino Unit to find that are applicable in each lesson.
- [4] Nsta. (n.d.). Disciplinary Core Ideas. Retrieved from <https://ngss.nsta.org/DisciplinaryCoreIdeasTop.aspx>  
This website was used in each lesson in the Measurements and Data Analysis unit to select appropriate disciplinary core ideas set forth by the NSTA that are at the center of each lesson.
- [5] Nsta. (n.d.). Crosscutting Concepts. Retrieved from <https://ngss.nsta.org/CrosscuttingConceptsFull.aspx>  
This website was used in each lesson in the Arduino module to select appropriate crosscutting concepts set forth by the NSTA that apply to each mathematics lesson.
- [6] Dcode. (2018, January 01). Global Variables - How to code an Arduino. Retrieved from <https://www.youtube.com/watch?v=jUL95G1C8Ws>  
This video is used as an instructional tool to engage students in the in the Arduino Unit 1:LEDs, Resistors, Buttons unit plan. Questions were developed based on this video for students to answer.
- [7] SIK Guide. (n.d.). Retrieved from <https://cdn.sparkfun.com/>  
This reference is used for teacher guidance. It gives them another resource to use with the lesson.