The 808er's Club

tech + music workshop for youth of color

(pronounced "Eight oh Eight-ers")

Workshop Manual

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What is the 808er's Club?

The 808er's Club is a five-day after-school workshop that introduces Black, Hispanic, and Native American youth, ages 10 to 14, to physical computing. The workshop addresses the lack of diversity in the technology industry by serving underserved communities, and by empowering these youths to see themselves as technologists. By the end of the workshop, students will create a digital music synthesizer (a drum machine), have the opportunity to compose songs using their machines and perform their compositions. Once the workshop is over, the students can take their drum machines home and repurpose the materials to create additional projects that will be provided to them. This program engages kids with tech through means that are familiar to create a positive workshop environment for kids in these groups to spark an interest in technology, by providing access to creative technologies.

Goals of The 808er's Club

The goals of the workshop are to:

- Introduce youth of color, ages 10 to 14, to physical computing in a way that allows them to put their knowledge to use in an engaging creative project.
- Empower these young people to continue to be creative after the workshop is over, and to not be hesitant about engaging with tech.

Learning Objectives of The 808er's Club

The students who take part in the 808er's Club workshop will learn about electricity, circuitry, and microcontrollers. The students will use this information to create a drum machine using simple physical computing materials, the Arduino IDE, a coding environment used to communicate with the microcontroller, and Scratch, an web software that will be used to produce and control sounds for the drum machine. After the drum machine is built, students can experiment with the sounds in Scratch and compose their own songs. The last day of the workshop is the performance. Students can perform their compositions in front of their peers.

By the end of the workshop, students will be introduced to:

- What electricity is and how the subatomic particles involved in electricity move.
- What a circuit is, including
    - What electric current is.
        - The manner in which electricity is generated and moves through a circuit.
        - Polarity within a circuit.
    - The basic components of a circuit.
        - Voltage.
- What a closed circuits is.
    - What an LED is.
        - The parts of an LED and how it works.
- What a short circuit is and what causes it.
- What an open circuit is.
- What series and parallel circuits are and how to build them.
- Materials that are conductive or insulating
    - Properties that make material conductive or insulating.
    - How to build a closed circuit using different conductive material.
- How a microcontroller works.
    - The parts of a microcontroller.
        - What input and output devices are and their function.
        - Analog and digital pins.
    - What code is and how it influences a microcontroller.

- How to control a piezo buzzer circuit with a microcontroller.
    - The function of a breadboard and how it works.
- How the Arduino IDE software works and how it influences the microcontroller.
- What the 808er's Club drum machine is and compose songs using it.
    - How electricity and circuitry work within the drum machine.
    - How the microcontroller and the code it is running in influence the drum machine.
    - What the Scratch program is and how it relates to the drum machine.
        - What sprites are.
        - How to change/add sounds within Scratch.
    - What a resistor is and how it works.

SWBAT:

Apply their knowledge of physical computing and circuitry to create future projects.

Why is the 808er's Club important?

The technology industry is a vast and ever-increasing field. Although the tech industry reported having 6.7 million workers in the United States in 2015,[1] involvement in the field is not being fully extended to Blacks, Hispanics, and Native Americans. Only 9% of the tech industry is represented by these groups.[2] The issue of racial diversity in technology can be linked to discriminatory hiring practices; poorly supported schools, specifically computer science programs; and the inability to see oneself as a technologist.[3] [4] [5] [6]

Diversity in tech is important because it affects minorities in two ways—economically and socially. It's a known fact that tech jobs are generally well-paying.[7] When minorities are excluded from the industry, they miss out on well-paying tech jobs that could increase their income and improve their quality of life. Socially, tech can affect the way society views people of color. Since the majority of technologists are White or Asian, the technology they create has the potential to be discriminatory—whether inadvertently or advertently. If more people of color were involved in the tech industry, perhaps technologies could be vetted through a diverse pool of people to check for mistakes before being released. Examples of these social errors include technology bias in algorithms that discriminate against people of color, and technology that stereotypes people of color.[8]

The hope of The 808er's Club is to give kids who aren't generally targeted for coding or technology programs or identify as technologist a chance to engage with creative technology and see themselves as technologists; possibly inspiring them to continue working with technology and making it a career.

Research

Technology Education and the 808er's Club

According to Code.org,

- only 40% of schools in the United States offer computer science programs.[9]
- "Black and Hispanic students who try AP Computer Science in high school are 7-8 times more likely to major in computer science."[10]

Since there is a shortage of computer science programs in schools, the 808er's Club addresses this issue because it's meant to be implemented in schools and community centers in areas where there aren't computer science programs. Studies show that Black and Hispanic students are more likely to major in computer science when they've had a chance to study it before entering college. The 808er's Club introduces to physical computing, a type of computer science, in areas where there aren't many, if any, computer science or tech programs.

Learning Styles, Learning Environments, and the 808er's Club

Constructionism is the belief that comprehension happens when a learner engages with the material being taught by building their own understanding of it.[11]

Many educators are moving away from the traditional way of teaching students—where the teacher is lecturing while the students copy notes—in favor of a more engaging, student-centered learning experience.[12] The goal of constructionism is to combine what the student learns from observing their own environment with new information that's being taught.[13] When students engage with the information in a more personal way, they will be more motivated to create. According to constructionist thought, self-motivation is the key to learning.[14]

Informal learning environments, which is where learning takes place outside of the normal classroom setting, are a great environment in which to teach kids. Not only is the setting typically different from normal classrooms, the teaching styles in informal learning environments also differ because there are usually no standardized tests or burden of maintaining proficient test scores.[15] The material that is taught in an informal learning environment can be learned without any added pressure. Students are free to focus on engaging with the lessons. This would be an

ideal environment in which to introduce new tech concepts and skills to kids.

The 808er's Club uses the constructionist method of teaching within informal learning environments. Within a reassuring environment, students build upon their understanding of electricity, and have the chance to apply their knowledge to create the drum machine. Students walk away from the workshop with something that they've built with their own knowledge and skills; proving that they are capable of working with technology, and hopefully inspiring them to view themselves as technologists, either now or in the future. This addresses the problem of not feeling comfortable enough to identify as a technologist.

The Benefits of Music to Kids

Music helps kids with a wide variety of skills, such as motor skills, social skills, expression, and pattern recognition; which are important skills in child development.[16] Motor skills determine how well a child can move with precision.[17] Gross motor skills affect things like walking, running, and jumping. Fine motor skills control small muscle groups and affect activities such as writing, drawing, and playing an instrument.[18] The development of fine motor skills has been linked to a child's achievement in school.[19]

Music ignites creativity and curiosity.[20] It can be used as a means of expression for many different thoughts and emotions. Music helps with pattern recognition, which is useful in math. Mary Luehrisen, executive director of the National Association of Music Merchants (NAMM) Foundation says, "a music-rich experience for children of singing, listening and moving is really bringing a very serious benefit to children as they progress into more formal learning."[21]

Music is embedded in many Black, Hispanic, and Native American cultures. Many genres of music that originate in these cultures speak of strength, resilience, and are celebrations of that particular culture.

The 808er's Club incorporates music into most of the lessons, so students get the physical, mental, and cultural benefits of working with music. The beatmaking aspect of the workshop allows for students to create recognizable patterns with music.

Many of the sounds that the students use are from instruments that are frequently used in the music of different cultures. The 808er's Club seeks to engage students by combining something that is familiar to them—music—with something that is new—physical computing.

Precedents

Over the years, there have been many organizations that were started that work within tech education. These organizations can be broken up into three categories—organizations that teach kids tech, organizations that specifically teach tech to underserved populations, and companies that provide tech kits to kids. The 808er's Club seeks to combine all three aspects into its low-cost workshop—teaching tech to kids of all genders, specifically underserved kids, and providing them with a tech kit to take home.

Name of organization	**Teaches tech?**	**Cost?**	**Specifically serves underserved populations ?**	**Provides tech kit?**
The 808er's Club	Yes	Starting at $16 per student	Yes	Yes
UA Maker Academy[22]	Yes	Free	No	No
ChickTech NYC[23]	Yes	Free	Yes	No
gadgITERATION[24]	Yes	N/A (defunct)	Yes	No
CoderDojo[25]	Yes	Free	Yes	No
Mouse[26]	Yes	Free	Yes	No
Black Girls Code[27]	Yes	$35 per student, per workshop	Yes	No
Blink Blink[28]	Yes	Starting at $32 per kit	No	Yes
Little Bits[29]	Yes	Starting at $39 per kit	No	Yes
Makey Makey[30]	No	Starting at $19.95 per kit	No	Yes

What should I consider when implementing the 808er's Club workshop?

How to implement the 808er's Club workshop

Places to Implement

The 808er's Club was developed to exist in an after-school or extracurricular environment, so that students have the space to play and explore while they learn. Below are things to consider if you want to implement the workshop on your own.

Examples of perfect places to implement the workshop:

Schools (after-school)[31]

Community Centers[32]

Makerspaces[33]

Libraries[34]

Funding Options

The supplies for the workshop, the take-home kits, and general facilitation costs can be funded in different ways. Decide whether you want the workshop to be free for the students, to be funded by your organization or an outside organization via grant; or if you want to charge per student (the price breakdown per student can be found in the Supplies section). You could choose to fund the workshop through these means and allow parents to decide if they would like to invest in the take-home kit. You could also choose to combine options. Decide which options would work best for your organization.

Free
host to workshop free of charge for students (the workshop supplies would still need to be funded).

Pro: Having a free workshop eliminates the financial barrier of entry and allows for more students to participate.

Con: Having a free workshop may not allow for the students to have take-home kits after the workshop has concluded.

Funded by outside organization via grant
apply for grants to fund the workshop and/or the take-home kits.

Pro: This could possibly allow for the students to have supplies that can go home with them, and help to build partnerships between community organizations.

Con: The grant process can be long, difficult, and competitive.

Charge per student: factor in the costs of the workshop supplies, take-home kits, and miscellaneous costs into a fixed price per student.

Pro: The students are guaranteed to have their own kit that they can take home with them at the end of the workshop.

Con: This also could be a barrier of entry for students who come from families that cannot afford the kit

Classroom Environment

Student Population

The 808er's Club is meant to primarily serve youth of color (Black, Hispanic, Native American), ages 10 to 14. However, although the workshop is primarily for these youth of color, do not exclude students who are not in those populations from participating in the workshop.

Number of Students

The ideal student to instructor ratio is 5:1. This makes it easier for each student to get the attention and help they need. If you are able to recruit knowledgeable volunteers to help, then by all mean, increase the number of students per class.

Equipment in the Room

- One computer/laptop for each students, with
    - USB port
    - web browser and internet access
- Headphones (optional, but useful)
- A table to keep supplies away from kids before they're needed
- Tables for students to sit at and build, that are away from the computers
- A door—especially if there are no headphones. It may get noisy with the cacophony of sounds that will be made.

To-do Before the Workshop

Well in advance

- Decide which funding option works best in your community.
- Choose a place to host the workshop, taking into consideration the space and equipment needs listed above.

One Month Before Workshop Day 1:

- Decide whether the workshop will run for five consecutive days, or for one day per week for five weeks.
- Advertise workshop: Begin to send out flyers, email blasts, and social media posts about the workshop.
- Put out a call for volunteers (if necessary).

Two Weeks Before Workshop Day 1:

- Order supplies (see Supplies section)
- Make of list of students. Include their:
    - Name
    - Age
    - Emergency contact
    - Level of familiarity with physical computing and circuitry
    - Favorite kind of music

One Week Before Workshop Day 1:

Download the following software on each of the computers that will be used during the workshop:

Adafruit Pro Trinket Bootloader (Windows only)

The only way for the computer to communicate with the microcontroller is to download the bootloader. You don't need to bother with the bootloader once it's been installed. It simply needs to be on the computer in order for the connection to be made. Find the setup tutorial here: learn.adafruit.com/adafruit-arduino-ide-setup/windows-setup. Linux and Mac do not need to have the bootloader installed.

Arduino IDE and Adafruit Pro Trinket board package setup

This is what will be used to write and upload code to the microcontroller. Arduino needs to know which microcontroller its writing to. However, it does not initially include the Pro Trinket in their list of microcontrollers, so you'll need to add the Pro Trinket to the list. Adafruit does a great job explaining the process for setting up Arduino. Instructions can be found here: learn.adafruit.com/adafruit-arduino-ide-setup/arduino-1-dot-6-x-ide.

Adafruit Pro Trinket library

This library has the functionality we need to create the drum machine using the microcontroller.

To download the library:

- Open Arduino
- In the menu, go to Sketch > Include Library > Manage Libraries…
- Search for “Pro Trinket USB Keyboard Library”
- Click Install
- Restart Arduino and check the Include Library list to see if the Pro Trinket USB Keyboard Library was added.

Warnings and Safety Tips

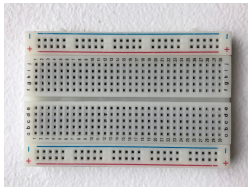
- Obey warning signs on electrical components.
- Make sure the polarity is correct when connecting parts of a circuit. Positive to positive, negative to negative. Opposites DO NOT attract in this case.
- Make sure components are not being overloaded. Be aware of the maximum amount of electricity each component can handle. Overloaded components = dead components, or a fire.
- Do not directly touch metal in a circuit. Although the voltages we are working with are low and won't harm you, it's a good habit to develop.
- Never use any electrical components near water. Water is conductive. Electrocution is a risk.
- When you want to upload code to the microcontroller, make sure to press the bootloader on the Pro Trinket microcontroller and wait for the blinking red light. Once the light starts blinking, you can upload your code.
- Do not disconnect the microcontroller from the computer while it is in upload mode. You will mess up the bootloader on the microcontroller.

What supplies do I need for the Workshop?

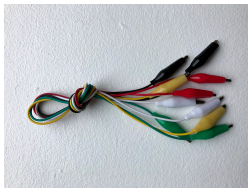
The supplies for the 808er's Club can be purchased here: 808ersclub.com/kits.

The 808er's Club Drum Machine Supply Kit

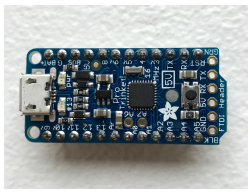
These supplies will go home with the kids at the end of the workshop. They can be reused to make other physical computing projects.



Breadboard

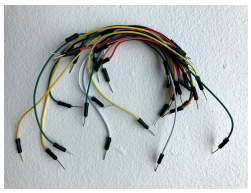


5 Alligator clips



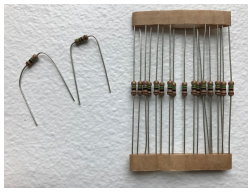
Microcontroller

Piezo buzzer



20 Male-to-male jumper wires

USB cable



1M ohm resistors

TOTAL: $16 per student

Workshop Supply Kit

These supplies are to be used during the workshop. These supplies will not be in the take-home kits.

Coin batteries[35]

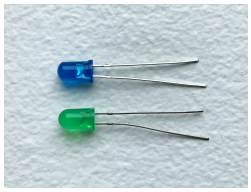
Clear tape[38]

Conductive copper tape[36]

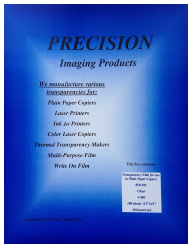
Aluminum Foil[39]

Play-Doh

Permanent markers[40]



3mm & 5mm LEDs



Transparent film[41]

Felt[37]

TOTAL: $63 for a class of 5–10 students.

$77 for a class of 11–20 students.

Visit 808ersclub.com/kits to see quantities for both sizes of the Workshop kit.

The curriculum serves as a script for instructors. Anywhere you see *(text)* is a note for instructors.

Day 1- Intro to Physical computing, Electricity and circuits

Learning Objectives for the Day

- Safety tips for working with electronics.
- The subatomic particles that influence electricity.
- How electricity flows.
- Polarity.
- The four components of a circuit.
- Voltage.
- Open circuits.
- Closed circuits.
- Short circuits.
- Series circuits.
- Parallel circuits.
- How an LED works.
- Conductivity and insulation.

Deliverables for the Day

- A simple closed circuit.
- A closed circuit using different conductive materials.

Supplies for the Day

- Worksheet 1: Electricity (one for each student)
- Worksheet 2: Types of Circuits (one for each student)
- Coin batteries
- LEDs
- Copper conductive tape
- Adhesive tape
- Strips of aluminum foil
- Strips of paper
- Strips of felt
- Can of Play-Doh
- Permanent markers

Safety Precautions- 2 minutes

Go over the safety precautions with the students. Make sure they are attentive so they know how to safely work with electricity.

- Make sure the polarity is correct when connecting parts of a circuit. Positive to positive, negative to negative. Opposites DO NOT attract in this case.
- Make sure components are not being overloaded. Be aware of the maximum amount of electricity each component can handle. Overloaded components = dead components, or a fire.
- Do not directly touch metal in a circuit. Although the voltages we are working with are low and won't harm you, it's a good habit to have.
- Never use anything electrical around water. Water is conductive.
- Obey warning signs on electrical components.

What is Physical Computing?-2 minutes

Since this is a physical computing workshop, it's useful to understand what physical computing is and how it relates to what we'll be doing.

- Physical computing is building physical systems using software and hardware that can sense and respond to our environment.
    - Software is computer programs, applications, and sets of instructions (code).
    - Hardware is the physical object that is used to interact with software.
    - We can touch hardware. We cannot touch software.

We are going to learn how to learn how to build hardware and how to control it with software.

What is Electricity?- 7 minutes

At the basis of physical computing is the use of electricity. This sections teaches students about electricity and how it moves.

Discussion: Electricity, where it can be found, and why it's important

- "Tell me something that uses electricity."
- "Based on some of the things you named, do you think electricity is important?"
- Electricity provide energy to many things from light fixtures to refrigerators to video games! That means we wouldn't be able to see in the dark, unless we used candle light, we wouldn't be able to store our food, unless we used ice blocks, nor would we be able to play video games."

What is electricity?

See Appendix to make copies of the Electricity and Types of Circuits worksheets. Hand out the worksheets to the students. The students can use their worksheets to follow along with the instruction.

Have you ever wondered what electricity was made out of?

- Electricity is the interaction of electrons and protons
    - An electron is a particle found in atoms with a negative charge.
    - A proton is a particle found in atoms with a positive charge.

How does electricity work?

- Electricity is made of electrical currents—the movement of electrons from atom to atom

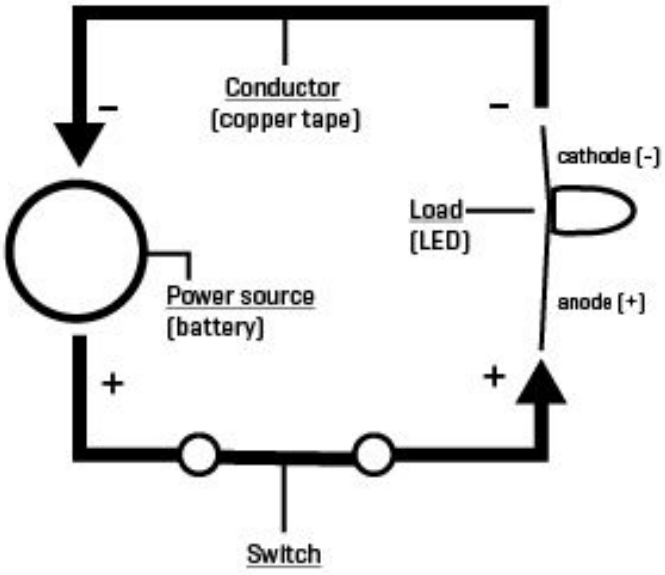
What is a circuit?- 10 minutes

An electrical circuit is the pathway that electrical current flows through.

- Think of it like this: electricity is like water, and the circuit is like the pipe that the water flows through.

How does a circuit work?

There are 5 main parts of a circuit.



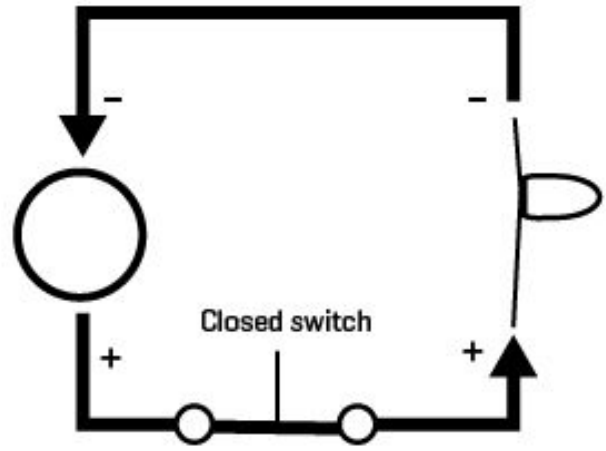
- The power source is the part of a circuit that provides energy (voltage) to something, including a battery or wall outlet. Where electrical current leaves the power source is positively charged. Every circuit needs a power source.
    - Voltage is the electric pressure from a power source that moves electrons from one atom to another. A volt is the measure of electric pressure.
- A switch creates a gap in the circuit. It either stops electricity from flowing or continues the flow of electricity. The switch is an optional part of the circuit.
- Material that allows electricity to flow through it is known as a conductor. The electrons of a conductive material are held loosely together, which allows electrons easily move from one atom to another. Copper wire is a good example of a conductor.
- The load is the part of a circuit that is being powered. A light bulb is an example of a load.
    - Discussion: Can you think of any other examples of a load?
        - Here are some examples: a washing machine, television, computer, hand dryer, and an iron.

- Ground is a part of the circuit where the electricity completes the circuit and returns back to the power source. Think of it as the opposite of the power source because the power source send out power. Ground receives the power.

It's important to know that electricity flows in **one** direction.

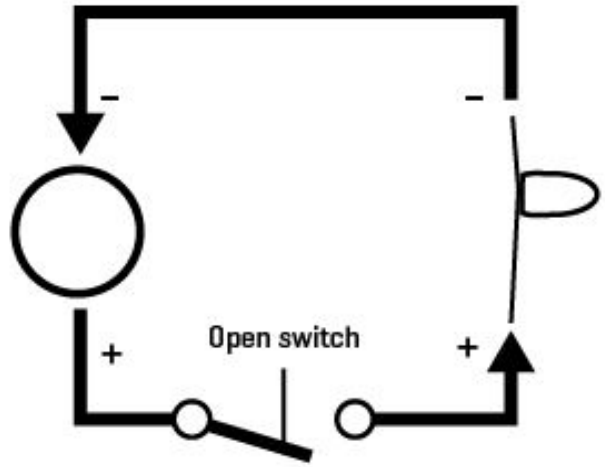
- In a circuit, electricity flows from the power source (which is positively charged) to ground (which is negatively charged).
- Electricity always starts at the positive pole and ends at the negative pole.

Types of Circuits- 5 minutes



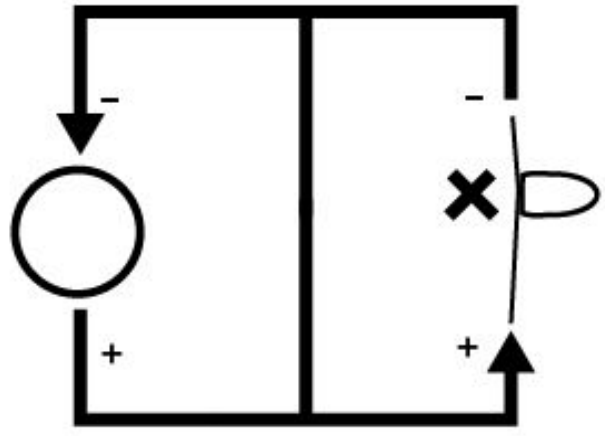
What is a closed circuit?

Our goal is today is to create a closed circuit. A closed circuit allows electricity to flow to all parts without interruption.



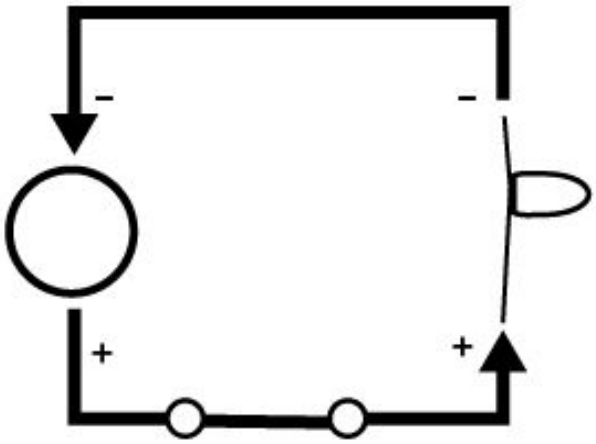
What is an open circuit?

An open circuit is an incomplete circuit, where the flow of electricity is interrupted. We can create an open circuit by disconnecting parts of the circuit, or by adding a switch to control the flow of electricity.



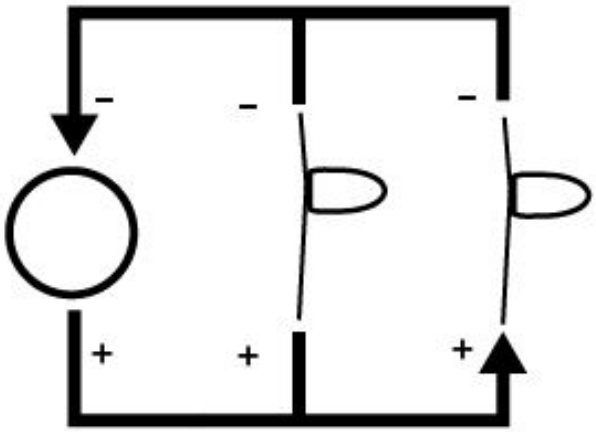
What is a short circuit?

When electricity in a circuit travel along an unintended path, a short circuit is created. Short circuits usually happen by accident. For example, when two wires in a circuit that are connected, the electricity is going to take the shortest route to get back to ground.



What is a series circuit?

When the electrical current has only one path to take, it's kind of circuit is known as a series circuit. Think of Christmas lights—when one stops working, they all stop working.



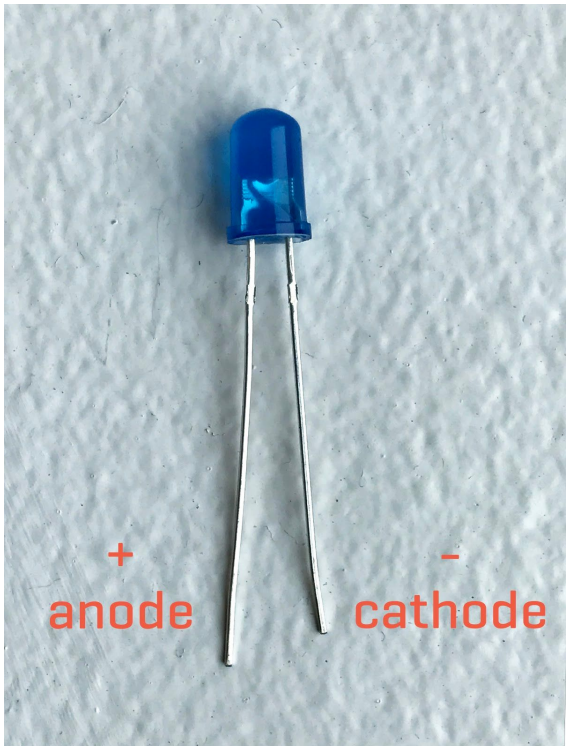
What is a parallel circuit?

A parallel circuit is where the electrical current is divided into two or more paths and then returns to ground along a common path to complete the circuit. We can have many different loads that have their own supply of power without having to go through the other loads. If we disconnected one load, the others would still work.

LEDs- 5 minutes

Give each student/group of students and LED to observe while you explain what they are and how they work.

We will be lighting up a Light-emitting diode or LED to show that electricity is flowing in our circuit. An LED is a type of load. LEDs give off light when electricity passes through them.



LEDs have two leads or legs—a long lead and a short lead.

- The long leg is the positive side of the LED and it is called the anode.
- The short leg is negative it is called the cathode.

LEDs only allow electricity to flow in one direction, so it's important to attach the correct side of the LED to the correct polarity. We have to be sure to connect the negative pole to ground and the positive pole to our power source; if we don't, our LED will not light up.

Activity: Building a Circuit- 15 minutes

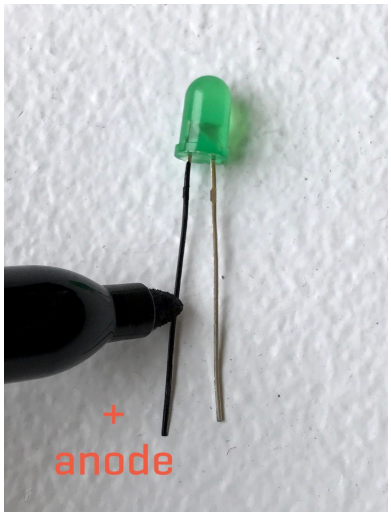
Students will trace along the circuit diagram on their worksheets with copper tape to create their own circuits. Pass out the materials listed below to each student.

Supplies per student:

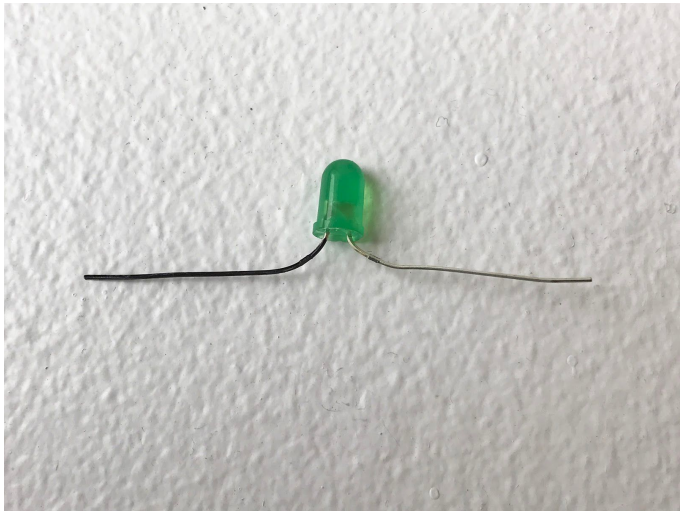
- Worksheet 1: Electricity
- 1 Coin battery
- 1 LED
- About 8 inches of adhesive copper tape per student
- 1-inch piece of adhesive tape
- 1 Permanent marker per table or group of students

Instructions:

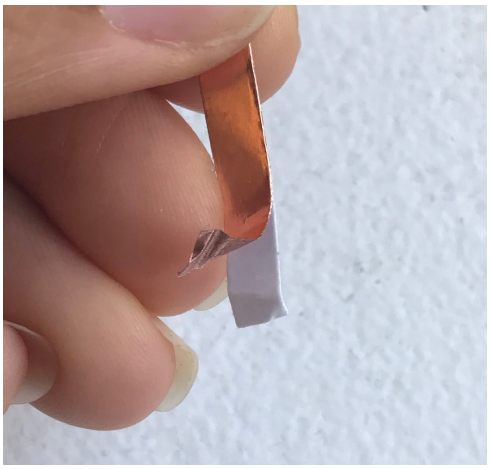
1. Identify which lead of the LED is positive. Remember, the positive lead is always the longest lead. Use the permanent marker to color this lead so that we can always identify it.



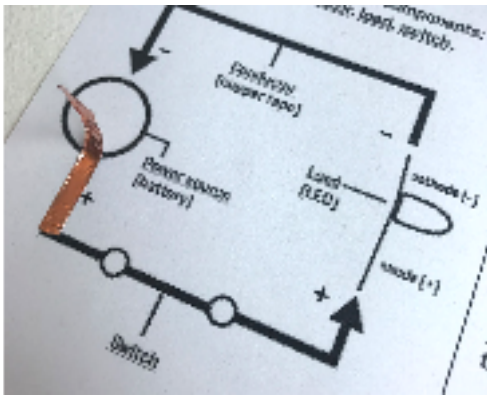
2. Bend the LED so that the leads are going in opposite directions.



3. Bend the end of the copper tape so that the backing is easier to peel off.

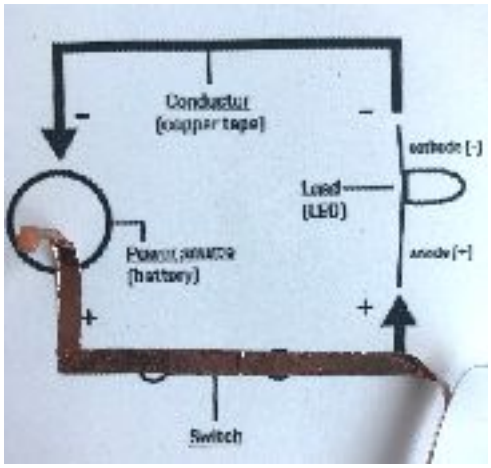


4. Start at the bottom of the first corner of the circuit diagram on Worksheet 1: Electricity. Apply copper tape from the corner until you reach the bottom of the battery outline on the worksheet.

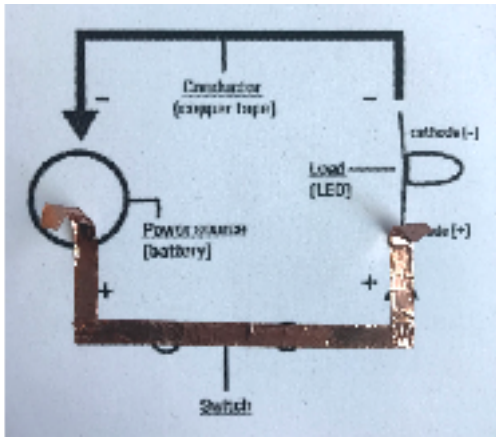


5. Tear the tape in the middle of the battery outline. Smooth the tape down starting at the bottom corner until the bottom of the battery outline. DO NOT smooth the tape over the battery outline.

6. Take a new piece of tape and place one end on top of the first piece of tape. Continue the line to the second corner. Tear the tape. Smooth the tape down circuit path on the worksheet. Smooth the tape so that it lays flat on the paper.

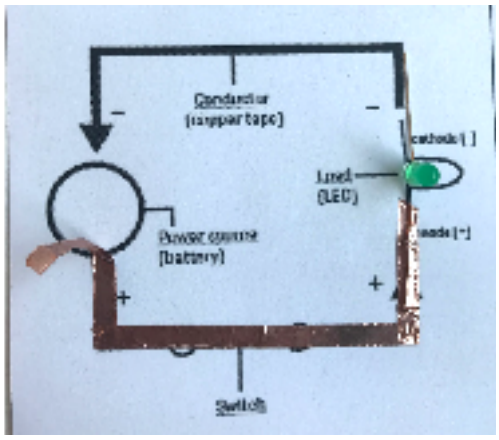


7. Take a new piece of tape, place one end over the torn end of the previous piece of tape, and smooth it down until you reach the anode of the LED outline on the worksheet.

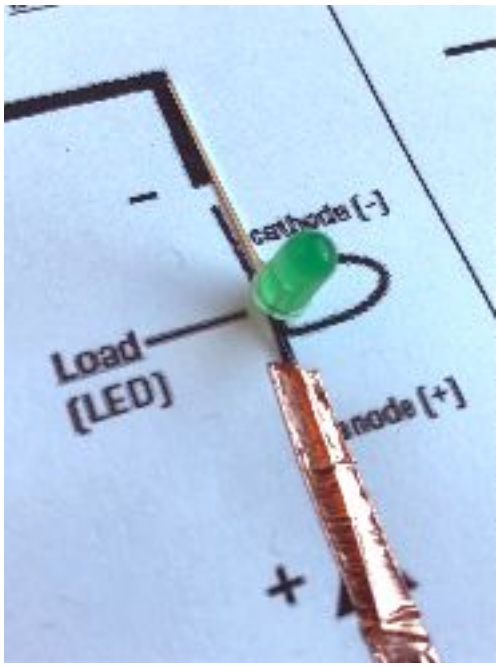


8. Tear the tape in the middle of the LED outline, but DO NOT smooth down the torn end.

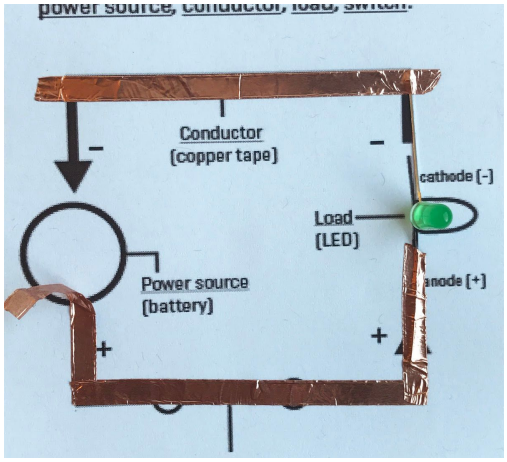
9. Place the marked lead of the LED (which is the positive lead) under the torn end of the tape and smooth the tape down.



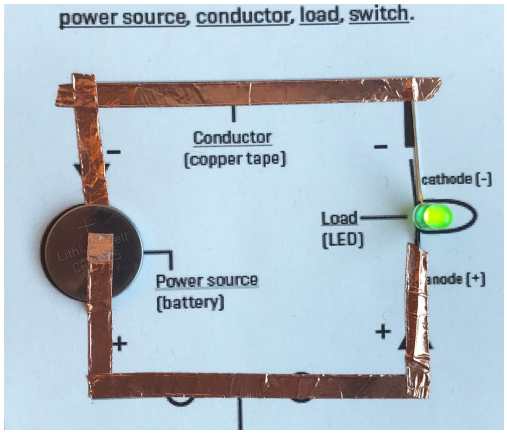
10. The unmarked lead of the LED (which is the negative lead) should be parallel to the line going up from the LED outline on the worksheet.



11. Take a new piece of tape and apply on top of the the positive lead of the LED, along the top line on the worksheet. When you reach the top left corner, tear the tape. Smooth the tape down.



12. Take a new piece of tape and place one end on top of the previous piece of tape. Continue the tape until you reach the middle of the battery outline. Tear the tape. Smooth the tape down.



13. Place the battery inside of the battery outline on the worksheet so that it is laying on top of the piece of copper tape. Make sure the tape connected to the positive side of the battery (top) is not touching the tape on negative side of the battery (bottom). You should notice that your LED is lighting up.

14. Use clear tape to tape down the battery so that it doesn't move around.

Troubleshooting

"My LED isn't lighting up."

- Is all the tape smoothed down?
- Is the tape at the corners of the circuit touching?
- Is the tape touching the leads of the LED?
- Is one line of tape laying under the battery and the other line of tape on top of the battery?
- Is the battery facing positive-side up?

If none of these solutions are working

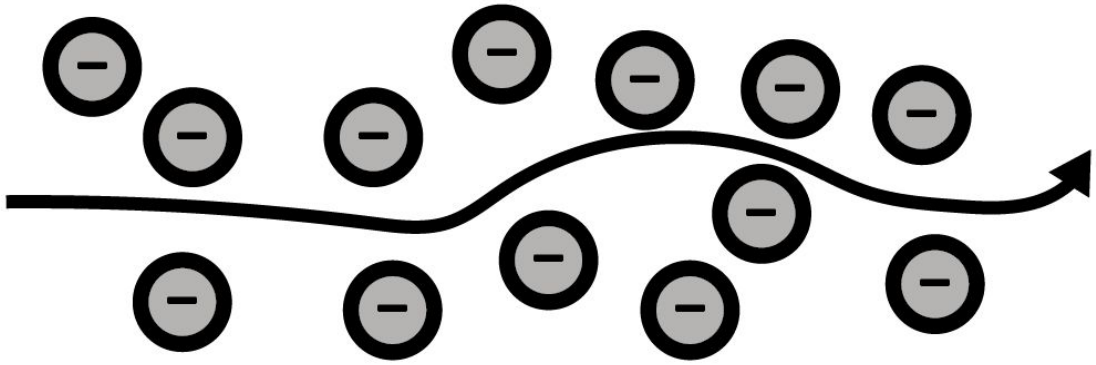
- The battery might be dead.
- The LED might be faulty.
    - You can test for these issues by pulling the battery and LED from the circuit and placing the battery between the leads of the LED so that the positive lead is touching the positive side of the battery and the negative lead is touching the negative side of the battery. If the LED lights up, there was something wrong with the circuit. If it doesn't, try lighting the LED with another battery, or switching the LED.

Further Exploration

*The "Further Exploration" section of the curriculum is for students who finish the activity before other students, or if you notice you have extra time after the activity. *

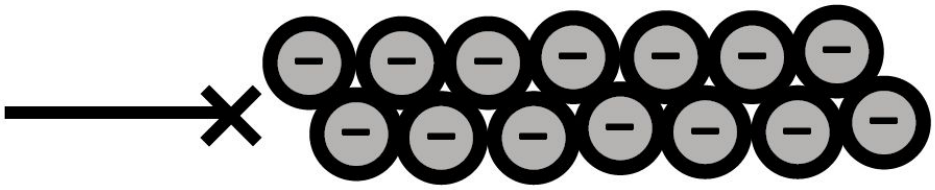
- "Can you reconfigure the circuit to add more LEDs to create a parallel circuit or series circuit?"
- "Can you add a switch to your circuit?"

What are Conductors and Insulators?- 2 minutes



We learned what conductors are—they are material that allows electricity to flow. These materials have some loosely held electrons, which move through them very easily. Most metals are good conductors. Most wires in electronics are copper because it is an excellent conductor, and copper is readily available.

What is an insulator?



We can have also have material that does not allow electricity to flow. Some materials hold their electrons very tightly. Electrons do not move through them very well. These things are called insulators. Examples of insulators include wood, paper, and rubber.

We are going to use the circuit you just created and add different material to the circuit to test if the material can carry electricity to our load, or not.

Activity: Conductor or Insulator?- 12 minutes

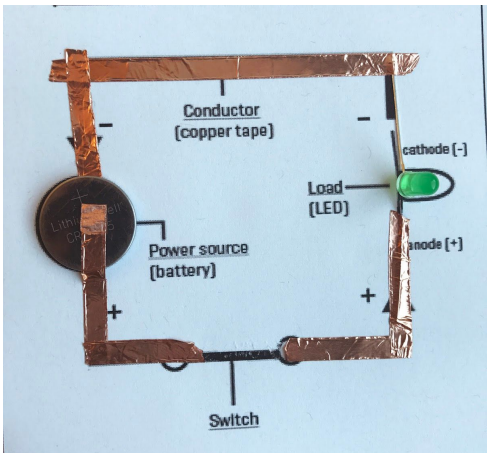
Pass out each material one at a time, saving the Play-Doh for last. Have the students hypothesize about whether the material is a conductor or insulator before handing out the next material. Then have the students test the material within their circuit. After testing each material, have student share their findings. Ask the class, "Was this material conductive or insulating?"

Supplies:

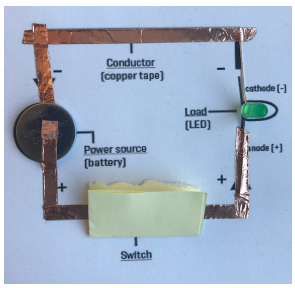
- 1 Strip of aluminum foil
- 1 Strip of paper
- 1 Strip of felt
- 1 Can of Play-Doh
- Circuit from previous activity

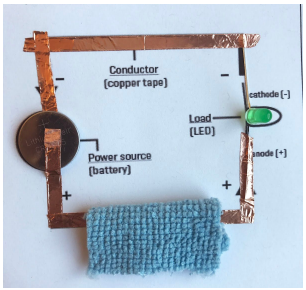
Instructions:

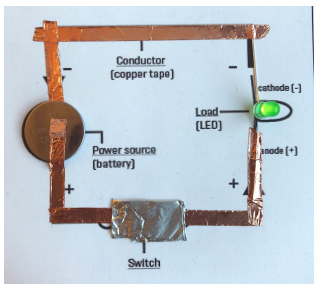
1. Using the simple circuit from the previous activity, break the line of copper tape where the switch is labeled on the worksheet. Tear it so that there is a gap in the tape.

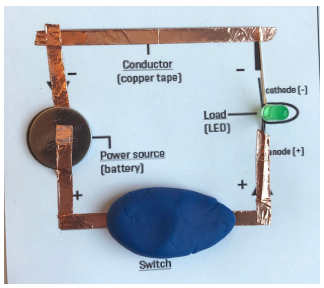


2. Testing one material at a time, place a material between the gap in the tape to see if it conducts electricity needed to light the LED. Use your fingers to press down on the materials to make sure the material is touching both ends of the tape.



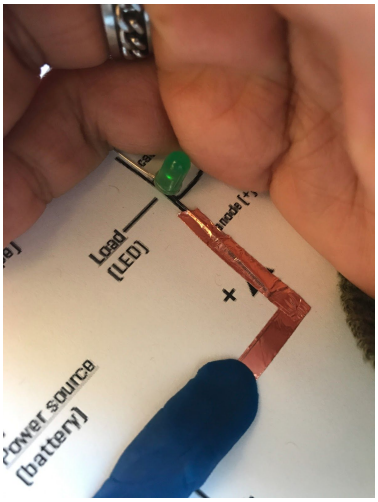






Pause here to allow the students to test each material.

The aluminum foil and Play-Doh should allow the electricity to flow to the LED; meaning, aluminum foil and Play-Doh are conductors. The felt and paper should not allow the electricity to flow. They are insulators.



The Play-Doh lights the LED, but dimly.

Further Exploration
"Think of other materials. Can you guess whether they are conductive/insulating?"

Clean up- 10 minutes
Have students neatly gather their materials together. Be sure to collect the material from students.

Review- 5 minutes

- What was your favorite part of the day?
- What are the 4 parts of a circuit?
    - Power source, battery, conductor, load
- What part of the circuit is an LED?
    - Load
- What part of the circuit is the copper tape?
    - Conductor
- What is a conductor?
    - Material that allow electricity to flow
- Name an example of an insulator.

Activity time: 61 minutes
Review time: 5 minutes
Clean up time: 10 minutes
TOTAL TIME: 1 hour, 14 minutes

Day 2- Microcontrollers

Learning Objectives for Day

Students will be introduced to:

- How a microcontroller works.
- How code influences a microcontroller.
- Input and output devices of a microcontroller.
- A solderless breadboard.
- A piezo buzzer.
- Wiring a circuit using a microcontroller.
- The Arduino IDE software.

Deliverable for the Day

- A piezo buzzer circuit controlled by a microcontroller.

Supplies for the Day

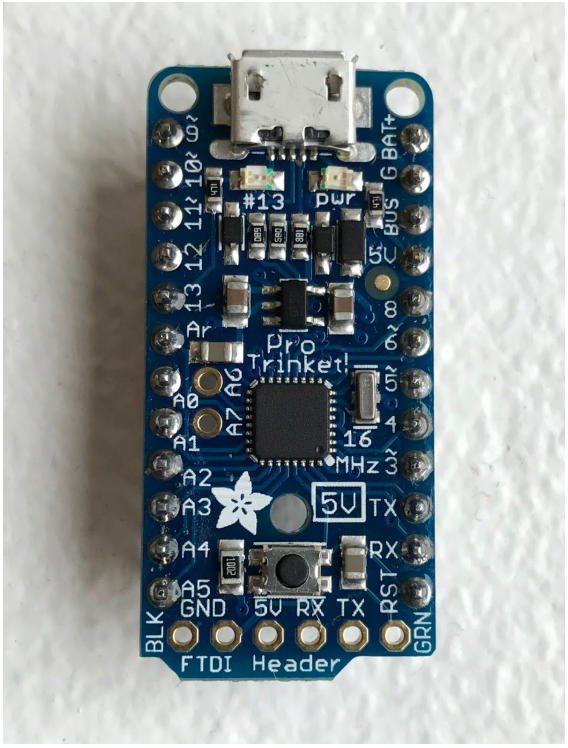
- Worksheet 3: Microcontrollers (one for each student)
- Worksheet 4: Breadboards (one for each student)
- Microcontrollers with USB cables
- Piezo buzzers
- Red jumper wires
- Yellow jumper wires
- Breadboards
- Arduino IDE software
- Buzzer code for Arduino: 808ersclub.com/piezo-buzzer-tutorial
- Desktop or laptop computers (one for each student)
- Microcontrollers
- LEDs (optional)

How Does the Microcontroller Work?- 15 minutes

Have students follow along on their worksheets as you explain microcontrollers.

What is a Microcontroller?

You noticed that when you lit up your LED in the previous session, it continued to stay on. Today we are going to learn how to control the electricity in our circuit. We can do this with a switch, but we are going to learn how to turn the load on and off automatically. We are are going to use a microcontroller to make that happen.



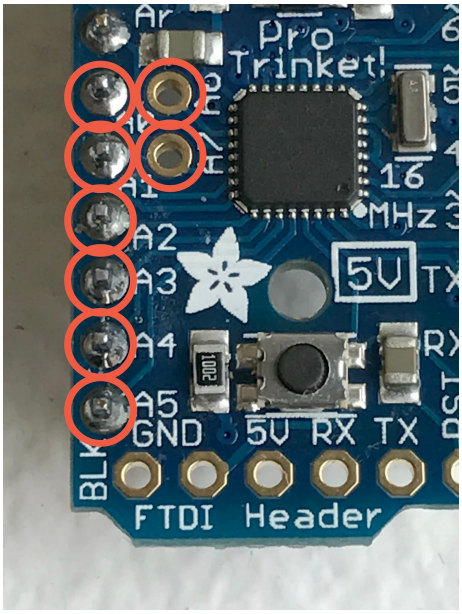
- A microcontroller is a single-purpose computer. Microcontrollers do one thing. The computers and laptops that we're used to using do many things.
- They contain a processor core (like the brain), memory, and input/output devices (attachments, accessories)

What Can a Microcontroller Do?

There are two types of devices that work with a microcontroller:

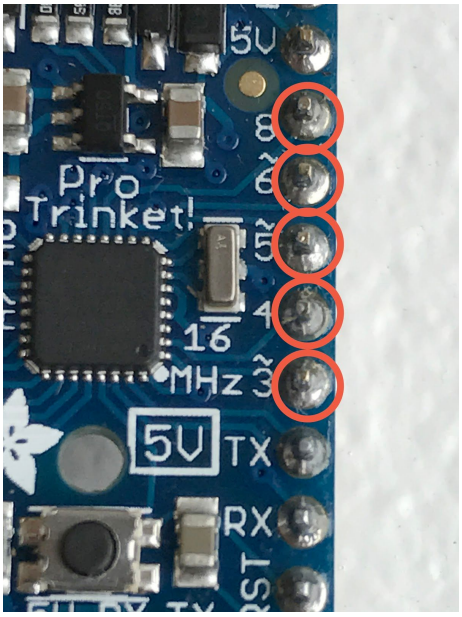
- Input device are attachments used to **send** information and signals **to a microcontroller**. For example: track the distance of an object use an ultrasonic sensor. The ultrasonic sensor is an input device in this circuit.
- Output device are attachments used to **receive** information and signals **from a microcontroller**. For example: make an LED light up for one second and turn off for one second continuously. The LED is an output in this circuit.
- We can think of the devices as the loads in our circuit. They are attached to the pins on the microcontroller.

There are two types of pins on the microcontroller:



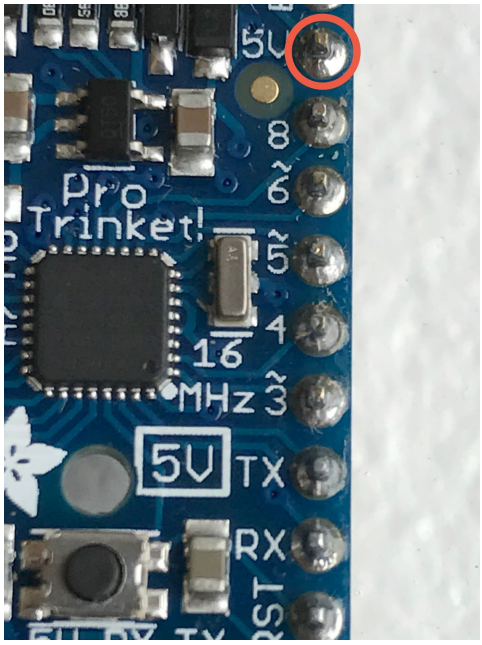
Analog pin- A pin on a microcontroller that receives information with an infinite (unlimited) number of possible values from input devices. On a microcontroller, they are usually marked as A0, A1, A2, etc.

For example: I can have a range of number from 1 to 200. The output device can send the microcontroller every possible number in between 1 and 200; such as 2, 54, 199.2 or 199.2375.



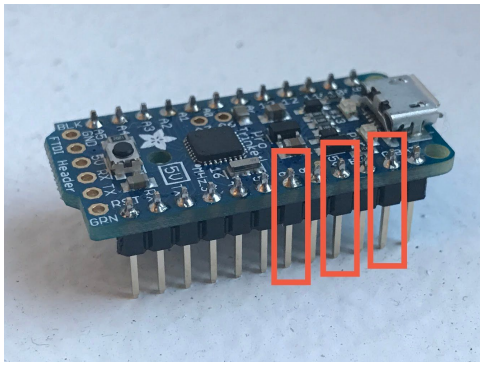
Digital pin- A pin on a microcontroller that sends or receives data with a finite (limited) number of possible values from input or output devices.

For example: the output device can send the microcontroller either a value of 0 or 1.



Input and output devices need power in order to function. When we connect a device to the 5 volts pin (5V), it automatically receives power. The microcontroller we will be using generates 5 volts. The microcontroller itself needs to be powered, either through a USB cable, or AC/DC power adapter.

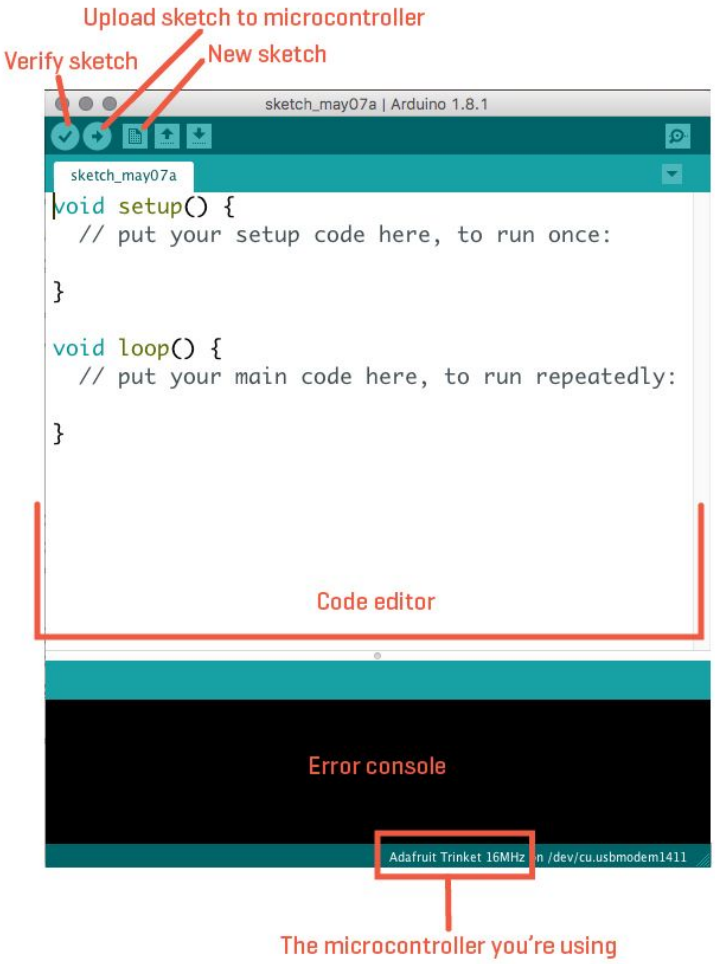
The digital and analog pins can also generate power, but when devices are connected to these pins, we have to tell the microcontroller when to generate 5 volts. They do not automatically generate power.



What is Code, and How Does it Influence a Microcontroller?- 5 minutes

The way that we tell a microcontroller what to do is by writing and uploading code— the written instructions for a microcontroller.

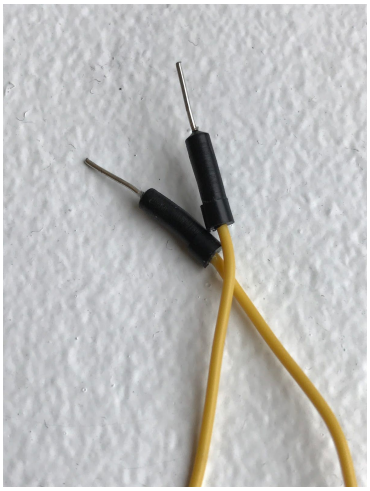
- Microcontrollers process information from code and perform commands specified by the code
- We will be using a special kind of software to write the code for the microcontroller. The software is called Arduino.



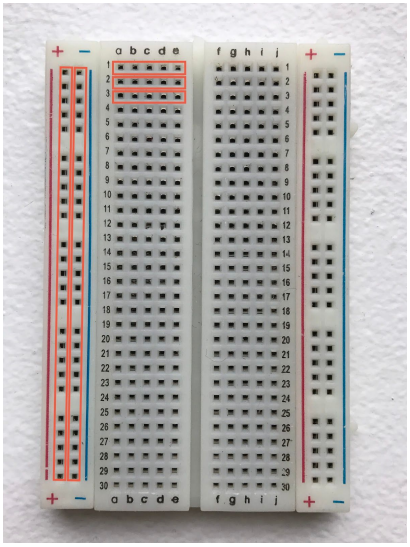
Arduino IDE software- The Arduino Integrated Development Environment—or IDE—is a software that is used to connect to some microcontrollers and allows users to write code, upload programs, and communicate with them.

What is a Breadboard?- 5 minutes

To connect our circuit together, we are going to use some new tools. They work the same way that the conductive tape worked in the first circuit we built.
We are going to jumper wires and a breadboard to link parts of our circuit together.

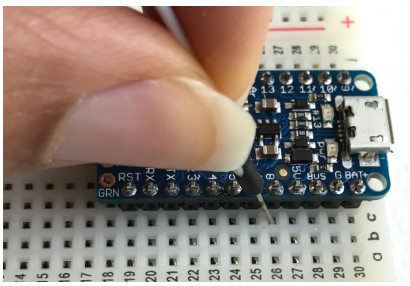


Jumper wires do the same function as the conductive tape—they are conductors that carry electricity.



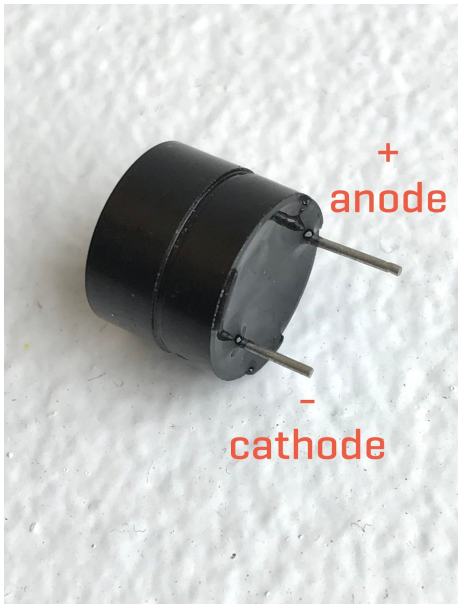
The breadboard allows you to create circuits without having to permanently bond components together. The breadboard connects components together in two different ways:

Each rail or row is connected together by a strip of metal. Any hole on that row is connected, so if two wires are plugged into the same row, they will be connected.



The second way it links components together is the negative and positive rails on the side of the breadboard. They are connected together by column, not row.

What is a Piezo Buzzer?- 2 minutes



The piezo buzzer will be the load in our circuit. It is an audio output device. When it receives power from the microcontroller, it will make a sound. Just like the LED, the buzzer had a positive side and a negative side. The positive side is noted by the + sign on the top of the buzzer.

Activity: Piezo Buzzer Control- 15 minutes

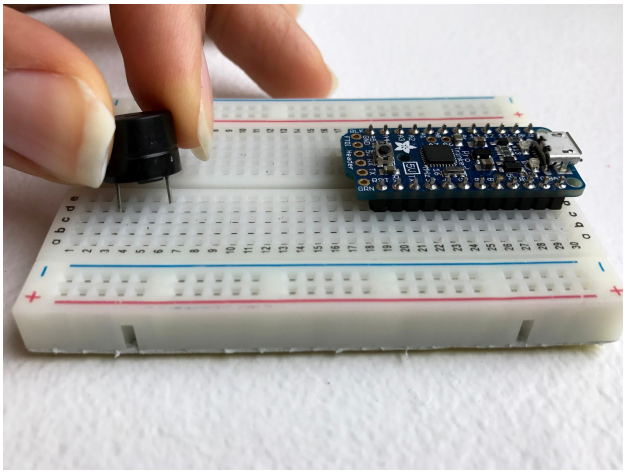
Supplies:

- Worksheet 3: Microcontrollers
- Worksheet 4: Breadboards
- Microcontroller with USB cable
- Piezo buzzer
- Red jumper wire
- Yellow jumper wire
- Breadboard
- Desktop or laptop computer
- Arduino IDE software

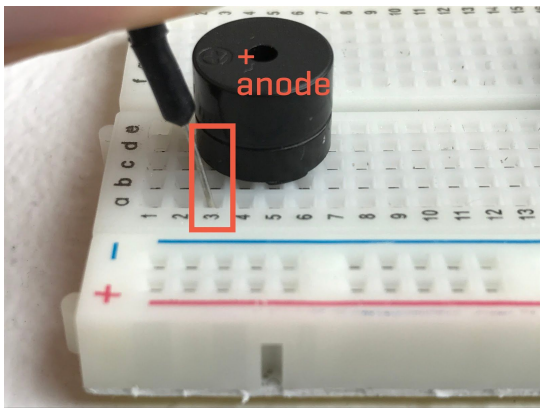
Instructions:

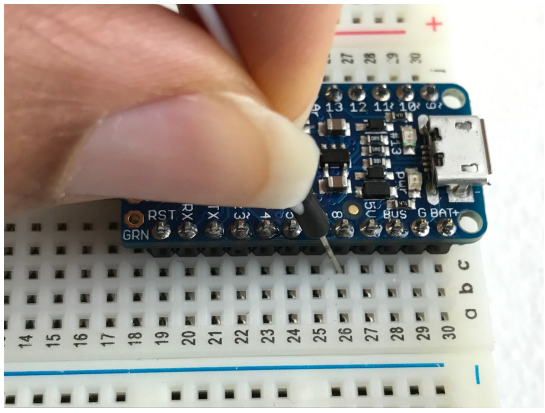
Explain each instruction one at a time so students won't be left behind.

1. Plug the piezo buzzer into the empty side of the breadboard so that the leads of the buzzer are not in the same rows as any of the pins of the microcontroller.

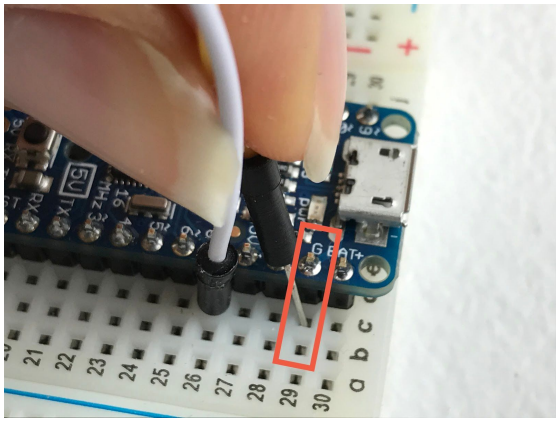
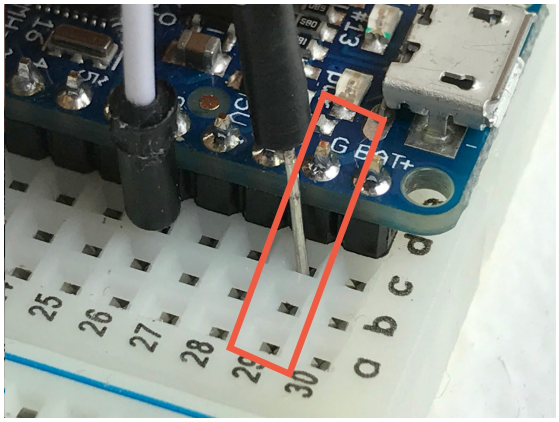


2. On the same row as one of the positive lead of the buzzer, connect a jumper wire. Plug the other end of the wire into the same row on the breadboard as the “8” digital pin of the microcontroller. This is where our power will come from. This is our positive pole.

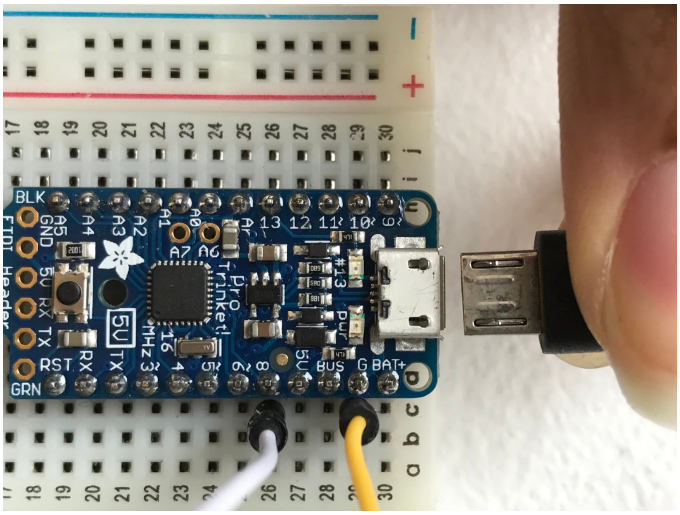




3. On the same row as the other of the leg of the buzzer (the negative lead), connect a jumper wire. Plug the other end of the wire into the same row on the breadboard as the “G” pin of the microcontroller (G stands for Ground). Remember, ground is the negative pole. The circuit is now closed. Next, we will supply power to it.

4. Plug the small end of the USB cable into the microcontroller. Plug the larger end of the cable into the USB port on the computer.

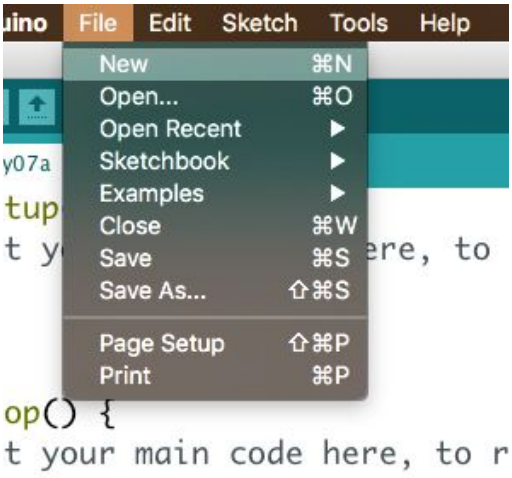


Explain circuitry
Pins can produce power just like the 5V pin. In our circuit, electricity is coming from pin 8, to the piezo buzzer, back to Ground. The code we will upload will tell the microcontroller when to send power out of pin 8.

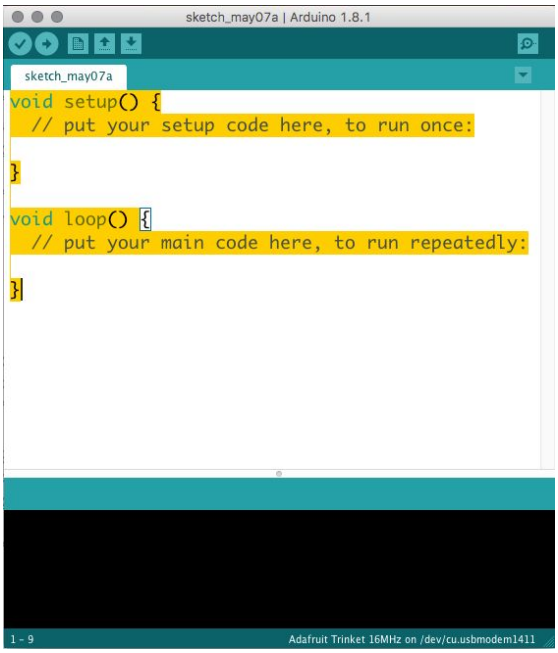
5. Go to 808ersclub.com/piezo-buzzer-tutorial to copy the code for the buzzer.

6. Open Arduino.

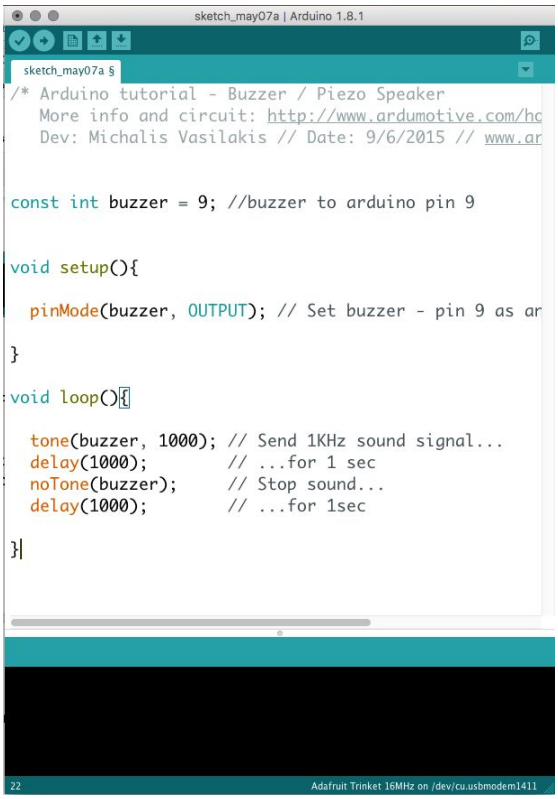
7. In the Arduino IDE, go to File → New.



8. Select all of the text in the new file and delete it.



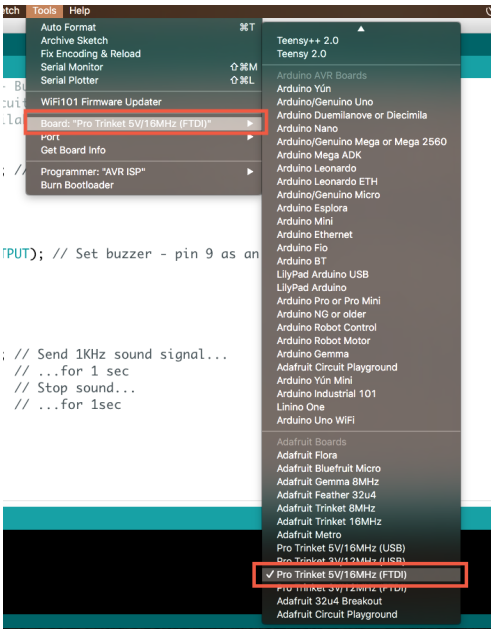
9. Paste the code you copied from the website into the Arduino IDE.



Explain code

We are telling the buzzer to be an output. In this case, it will output a 1000 hertz tone for 1 second, then stop outputting sound for 1 second and repeat forever (or until we unplug the microcontroller). Every second, the buzzer receives 5 volts, which is what causes it to buzz.

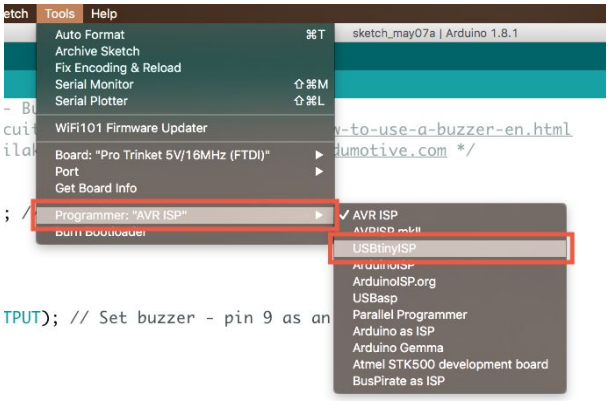
10. On the menu bar at the top of the screen, go to Tools → Board:



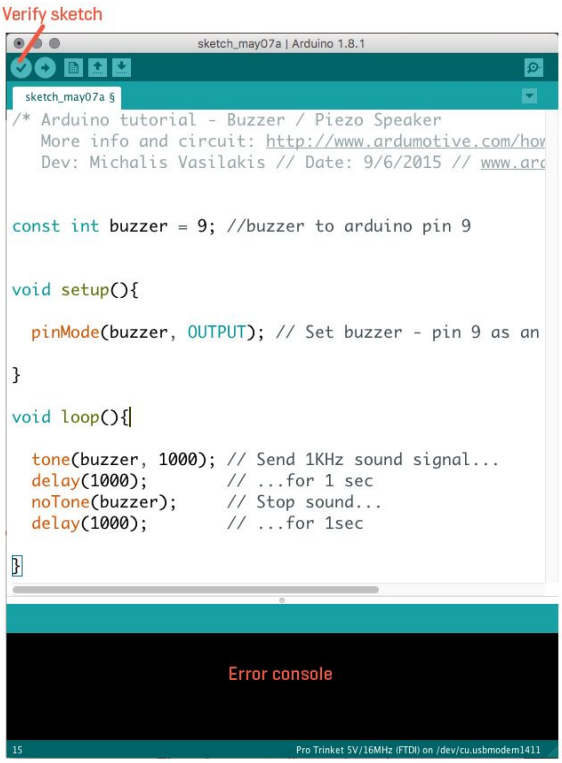
11. Select "Pro Trinket 5V/16MHz (USB)." We need to tell Arduino which kind of microcontroller we're using.

12. On the menu bar at the top of the screen, go to Tools → Programmer:

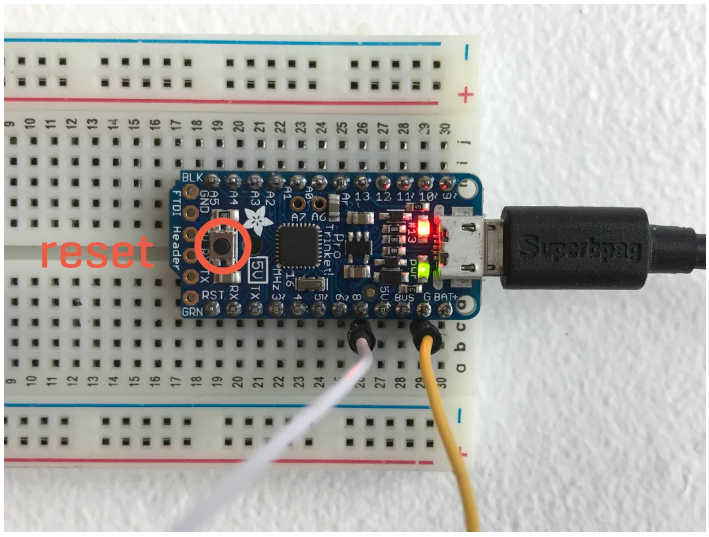
13. Select "USBtinyISP."



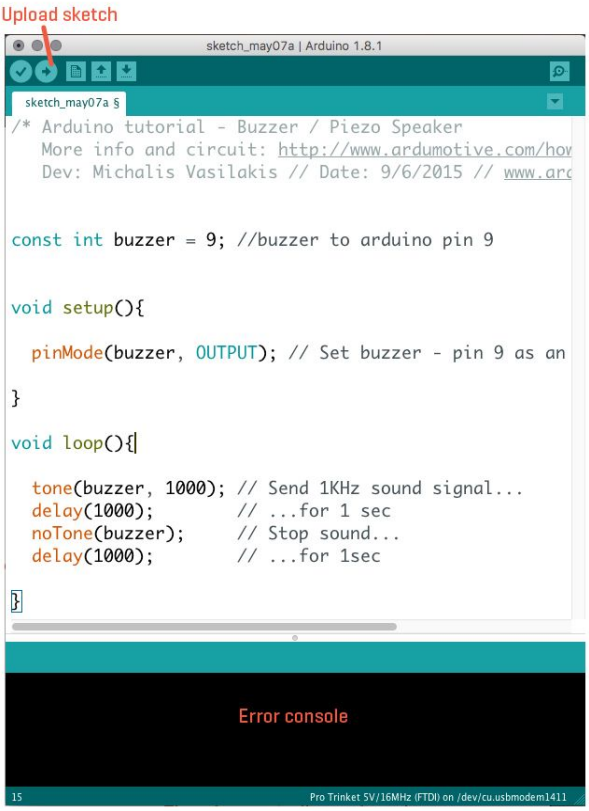
14. Click the Verify button (checkmark) at the top of the window to make sure there are no errors (error messages will pop up in orange at the bottom of the window).



15. If there are no errors, press the white reset button on the microcontroller. A red light should start blinking on the microcontroller. This is puts the microcontroller in bootloader mode, which means we can upload code when during this time. You will get an error if you try to upload code without pushing the reset button. **YOU COULD POSSIBLY RUIN THE MICROCONTROLLER IF YOU DO NOT ACTIVATE BOOTLOADER MODE WHEN YOU'RE TRYING TO UPLOAD CODE**.



16. While the red light is blinking, click the Upload button (right arrow) in Arduino. When we "upload," we send the code to the microcontroller.



Further Exploration:

- "Can you change the how long the buzzer is on or off?"
- "Can you add an LED to the circuit to match the rhythm of the tune?"
- "Can you make a switch to open and close the circuit?"
- "Can you change the tone the buzzer outputs?"

Troubleshooting

"I'm getting errors in Arduino."

- Was every line of the code copied from the website and pasted into Arduino?
- Is the correct board selected?
    - Go to Tools → Board:... to make sure "Pro Trinket 5V/16MHz (USB)" is selected.
- Is the correct programmer selected?
    - Go to Tools → Programmer:... to make sure "USBtinyISP" is selected.
- Was the microcontroller in bootloader mode?
    - Press the reset button on the microcontroller and try to re-upload the code while the red light is blinking.

- Was the microcontroller plugged in?
- Was the correct port selected?
    - Go to Tools → Port. Select the last port on the list. If that doesn't work, try the other ports.

"My buzzer isn't making any noise."

- Are the wires pushed down all the way into the breadboard and the microcontroller?
- Are the positive and negative side connected to pin 8 and ground, respectively?
    - Is the wire from pin 8 in the same row as the positive side of the buzzer? Remember, rows are connected together, not columns.
    - Is the wire from ground in the same row as the negative side of the buzzer?

Clean up- 5 minutes

Review- 5 minutes

- What was your favorite part of the day?
- What is a microcontroller?
    - A "special purpose computer" that does one thing well.
- What is an output?
    - An attachment that receives information from a microcontroller.
- What is code?
    - Instructions for the microcontroller.
- What is a breadboard?
    - Helps us to create circuits that aren't permanently bonded together
- What is a piezo buzzer?
    - An audio output device

Activity time: 52 minutes
Review time: 5 minutes
Clean up time: 5 minutes
TOTAL TIME: 1 hour, 2 minutes

Day 3- Building the drum machine + using Scratch

Learning Objectives for the Day

Students will be introduced to:

- Scratch and how it is influencing the drum machine.
- Resistors.

Deliverable for the Day

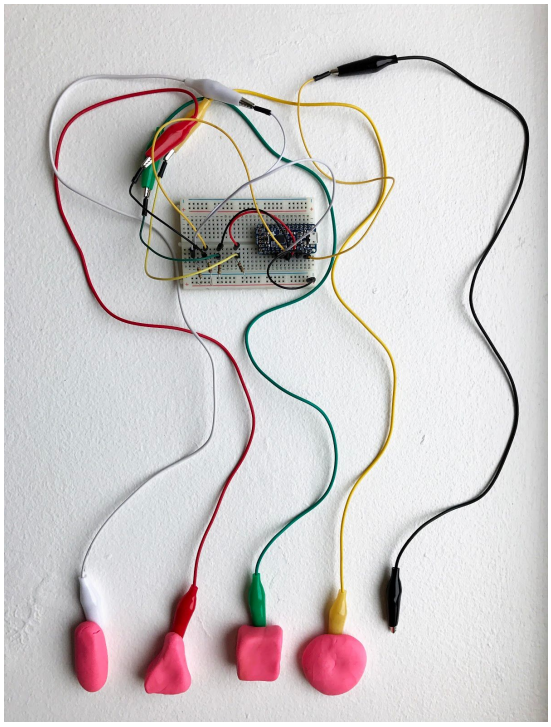
- The 808er's Club Drum Machine.

Supplies for the Day

- Microcontrollers with USB cables
- Breadboards
- Jumper wires
- Resistors
- Alligator clips
- Cans of Play-Doh or other conductive material
- Desktop or laptop computers
- Arduino IDE software
- Scratch Drum Machine project: tiny.cc/808ersclubdrum

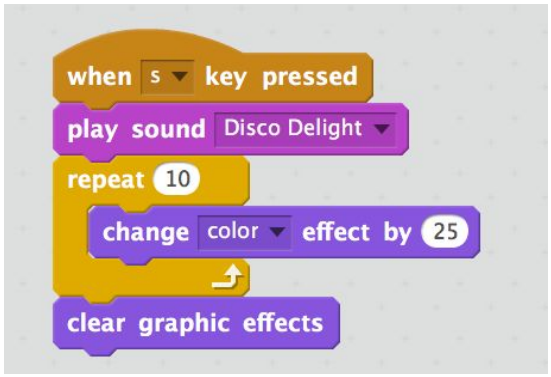
Scratch and the 808er's Club Drum Machine- 5 minutes

Today we will be building our own drum machines. We will be using a web program called Scratch along with microcontrollers.



What is Scratch?

Scratch is a free programming language and online community. It is a visual way of coding. It allows you to drag and drop blocks to create commands.

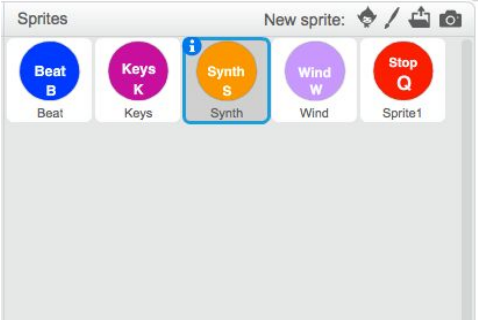


We will be using Scratch to play the sounds on our drum machines.

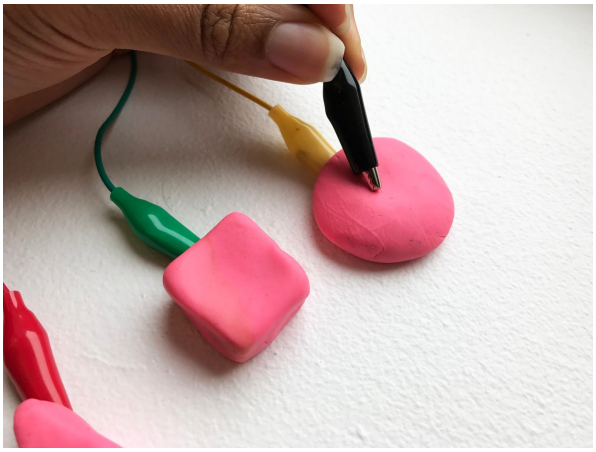
How does electricity and circuitry influence the instrument?
Show the students that 808er's Club Drum Machine Scratch project while you explain what it does.

Code is uploaded to the microcontroller that tells it to act like a keyboard. Each touchpad represents a different letter—B, K, S, and W.

In Scratch, B, K, S, and W are sprites. Clicking on a sprite allows you to change its specific characteristics. This is how we are going to change the sounds. A sprite is a computer graphic that moves and is treated as an individual object.



When a touchpad is tapped by the Ground clip, the microcontroller recognizes that the circuit had been completed. The microcontroller thinks a specific key has been pressed.



- Since the drum machine is connected to the computer, it takes over as the keyboard.
- When the 808er's Club Drum Machine Scratch project is open, the code says, for example, "when B is pressed, play this sound."

What is a resistor?- 5 minutes

We will be building 4 different circuits for our drum machine. We'll be using jumper wires and a breadboard to connect the parts of the circuit together. We will also need to add a new component to the circuit—a resistor. A resistor is just like a jumper wire because it connects parts of a circuit together, but it has a special ability—it limits or regulates the flow of electricity.

- Think of it as a kink in a water hose. What happens to the water pressure? It slows down to a trickle, right? The resistor acts like a kink in our circuit.
- Sometimes the amount of electricity that the power source generates is too high for the load, which can cause damage to the load, or a fire.
- We will be using a resistor in our circuit. We do not want to overload the microcontroller with more volts than it can handle. Since everything around us has an electrical charge, we want to protect the microcontroller from random charges.

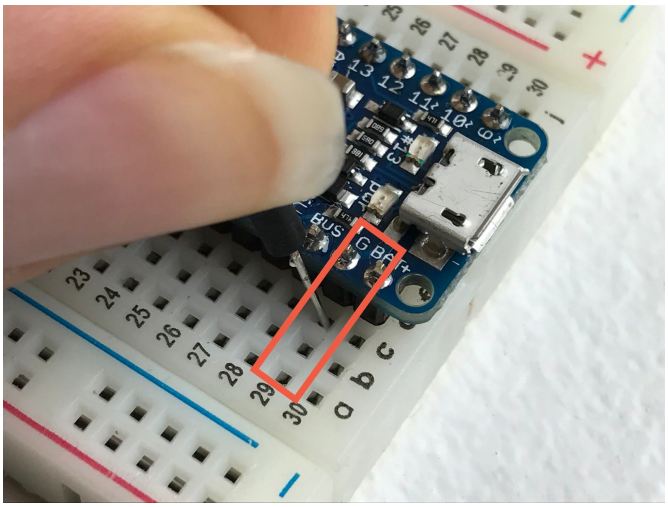
Activity: Building the 808er's Club Drum Machine- 40-50 mins

Supplies:

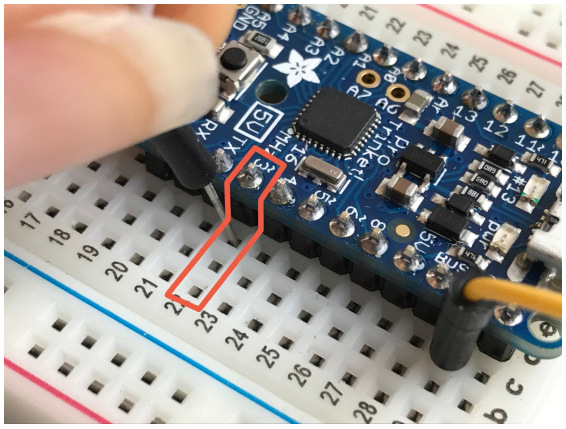
- Microcontroller
- Breadboard
- 10 jumper wires
- 4 resistors
- 4 alligator clips
- 4 balls of Play-Doh or other conductive material
- Desktop or laptop computer
- Arduino IDE software
- Scratch Drum Machine project: tiny.cc/808ersclubdrum

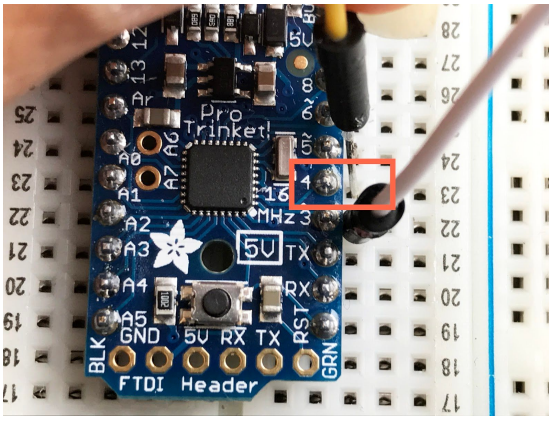
Instructions:

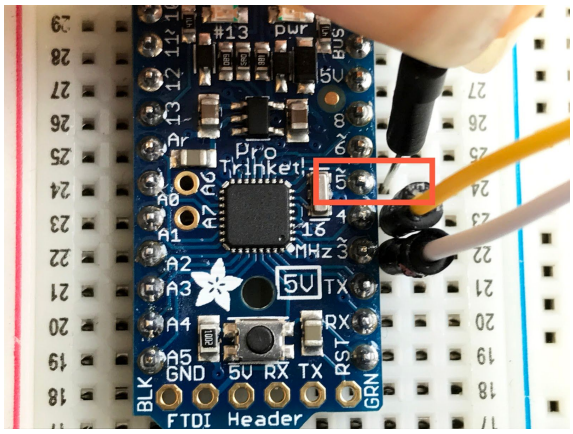
1. Grab a jumper wire. Plug one end of the jumper wire into the same row on the breadboard as the “G,” or Ground pin of the microcontroller. The other end of this wire will remain unplugged from the breadboard.

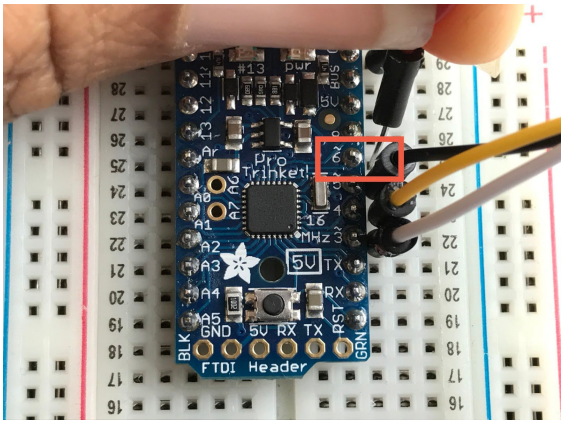


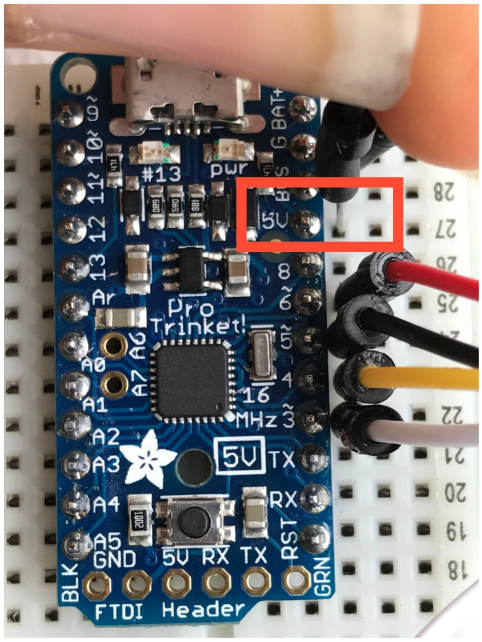
2. Grab another jumper wire. Plug one end of the jumper wire into the same row on the breadboard as digital pin 3 of the microcontroller. Repeat this step for pins 4–6, and the 5V pin.



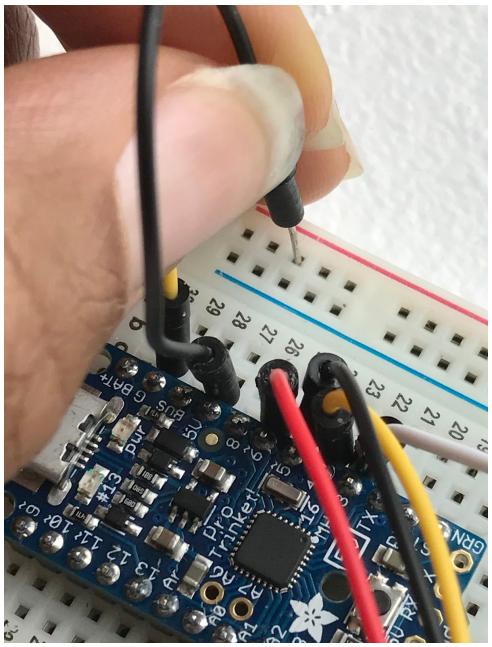




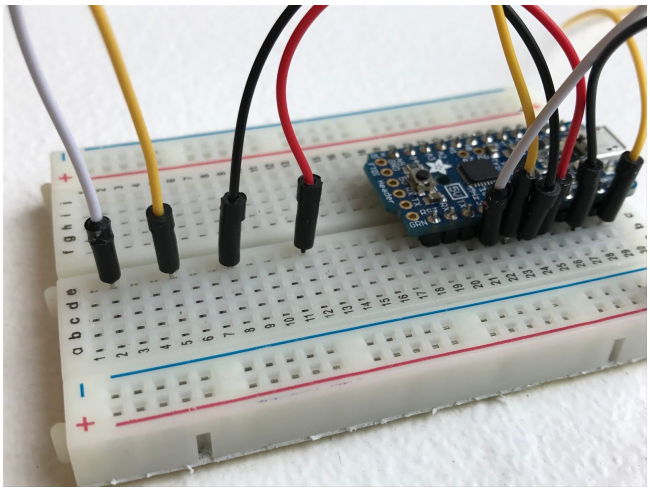




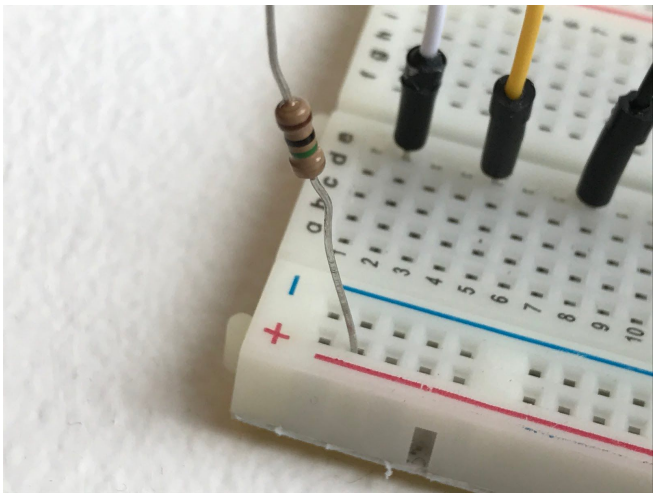
3. Plug the free end of the 5V jumper wire into the positive rail of the breadboard.



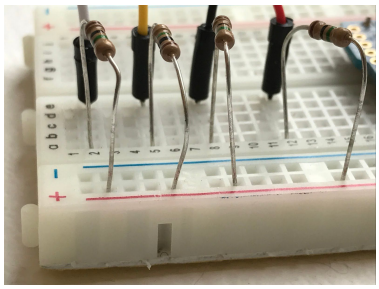
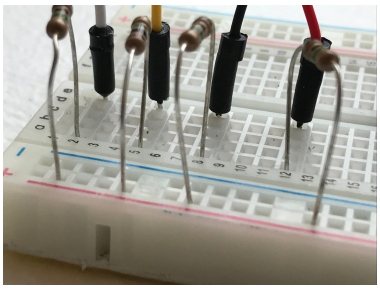
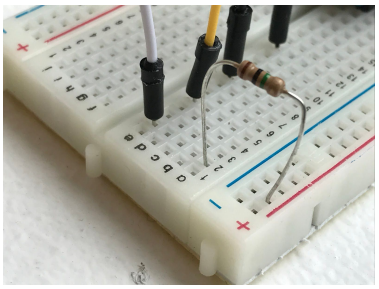
4. On the empty side of the breadboard, plug the free ends of the jumper wires for pins 3-6 into different rows. (They can be in the same column, e.g. column A, but NOT in the same row, e.g. row 11). Leave space in between each row for the other components we will use in our circuit.



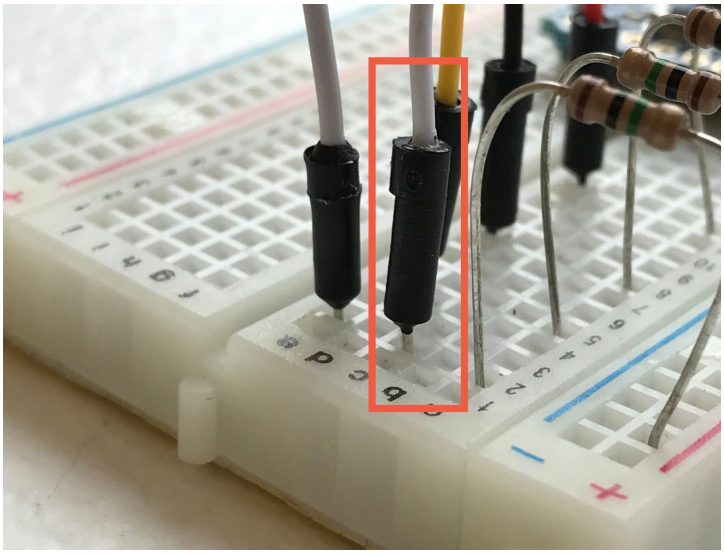
5. On the positive rail, plug one leg of each resistor into the empty holes near the jumper wires for pins 3–6.



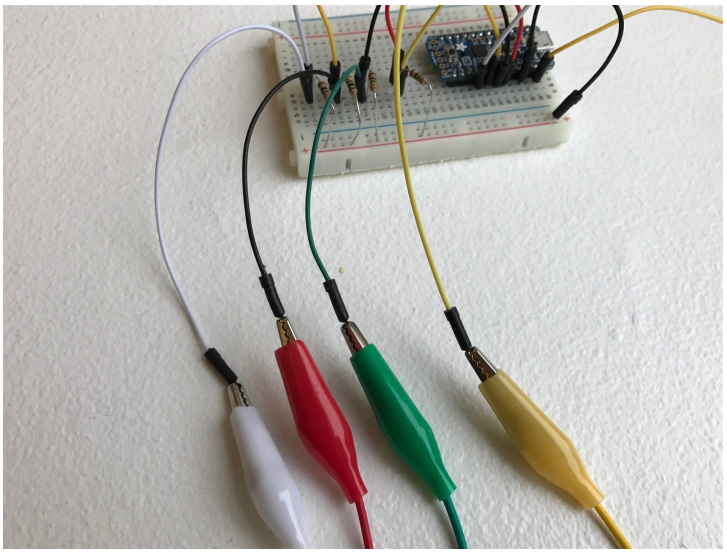
6. One by one, bend the resistors and plug the free ends into the same rows as the wires from pins 3–6. One resistor leg per row.

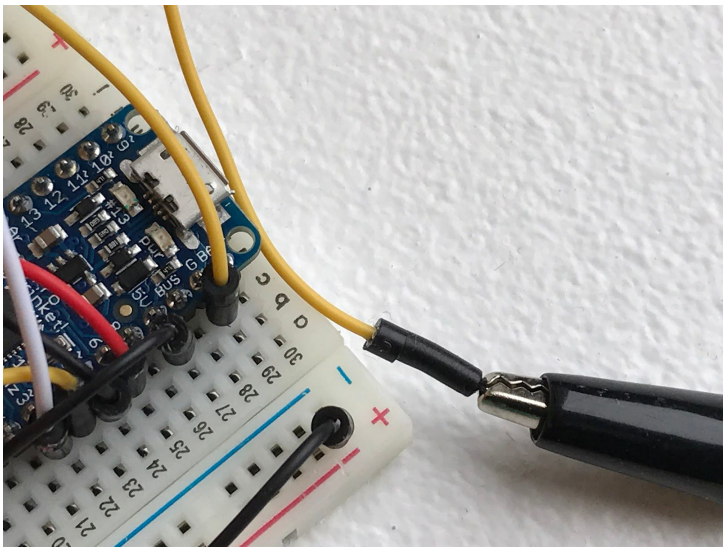
7. With the 4 remaining jumper wires, plug one end into the same rows as wires from pins 3–6 (e.g. one wire in row 14, one wire in row 16…).



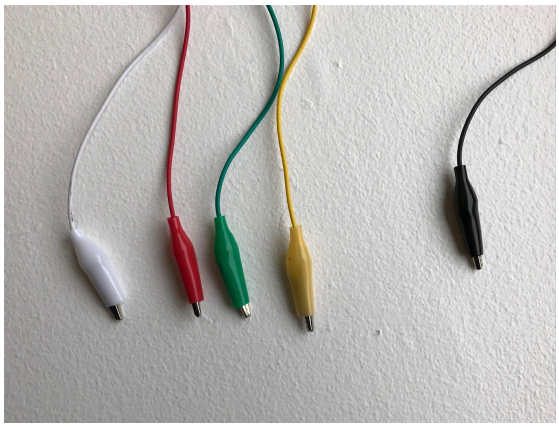
8. Clip one an alligator clip to the loose ends of each wire.

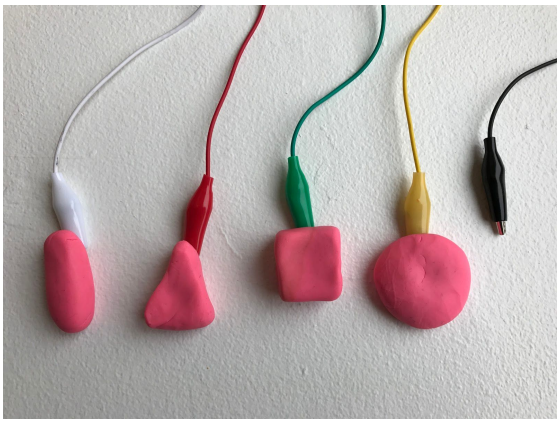


9. Clip an alligator clip to the loose end of the G pin wire. This will be our controller clip. We will use this clip to tap the other clips, which will trigger a sound. When we touch the Ground clip to the other clips, we are closing the circuit. Each clip is its own circuit.



10. Make 4 shapes out of Play-doh. Press the shapes on the end of the alligator clips, EXCEPT for the clip attached to G. Leave the G clip uncovered.



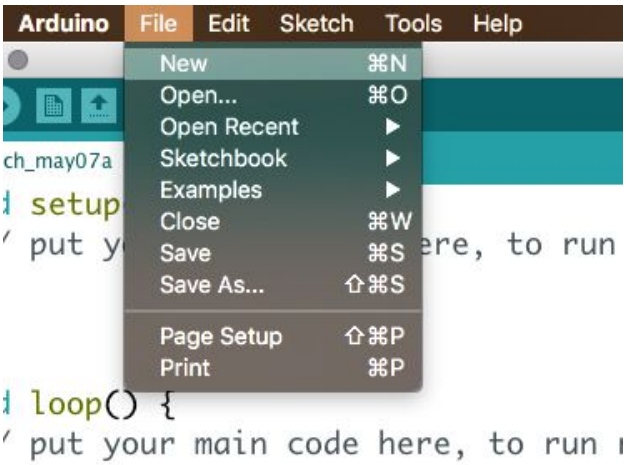


Explain circuitry

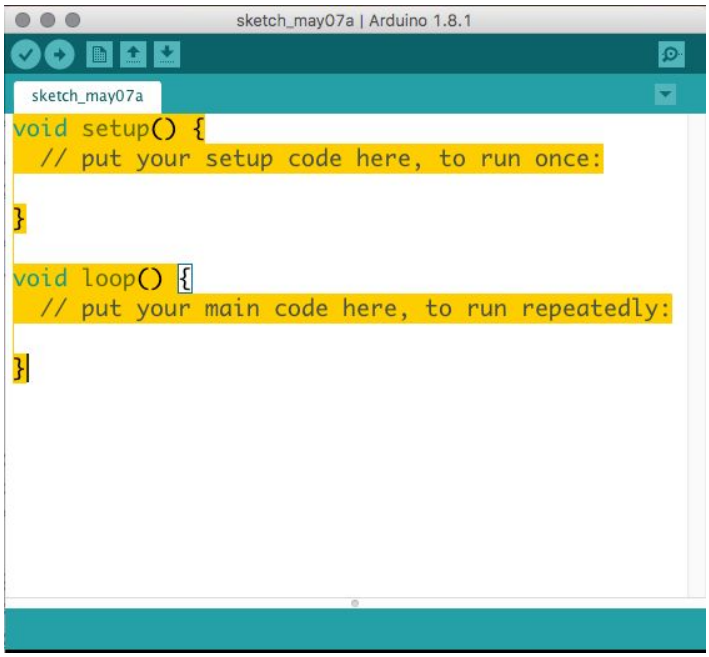
The electricity comes from the 5V pin, through the resistor, through the wires and alligator clip, to the Play-Doh touchpad. However, the circuit is not closed until we touch the touchpad with the G clip.

11. Go to 808ersclub.com/drum-machine-tutorial to copy the 808er's Club Drum Machine Arduino code.

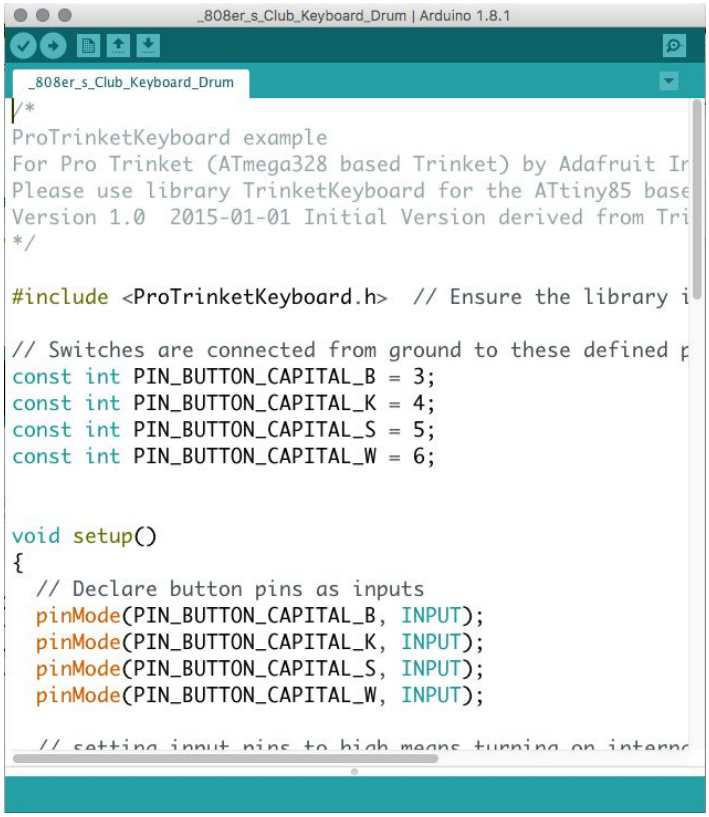
12. Open Arduino. In the Arduino IDE, go to File → New.



13. Select all of the text in the new file and delete it.

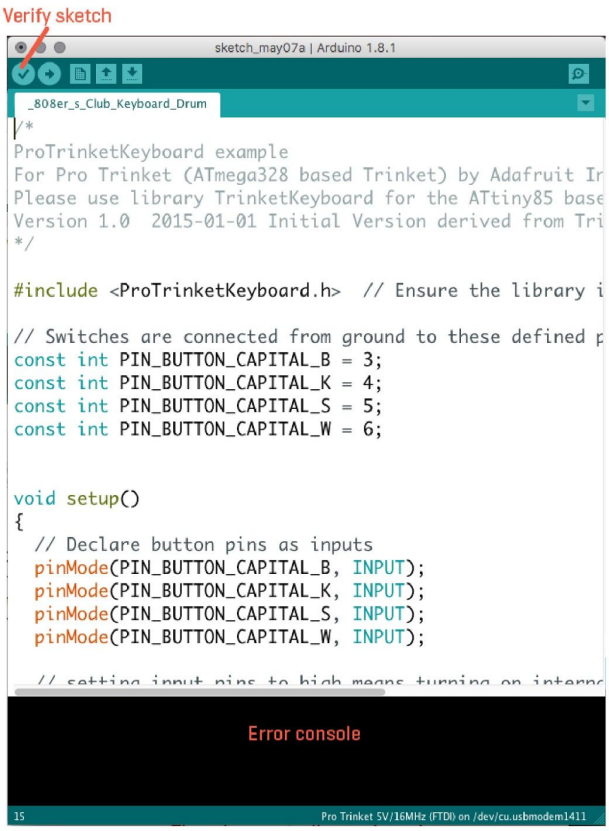


14. Paste the code you copied from the website into the Arduino IDE.

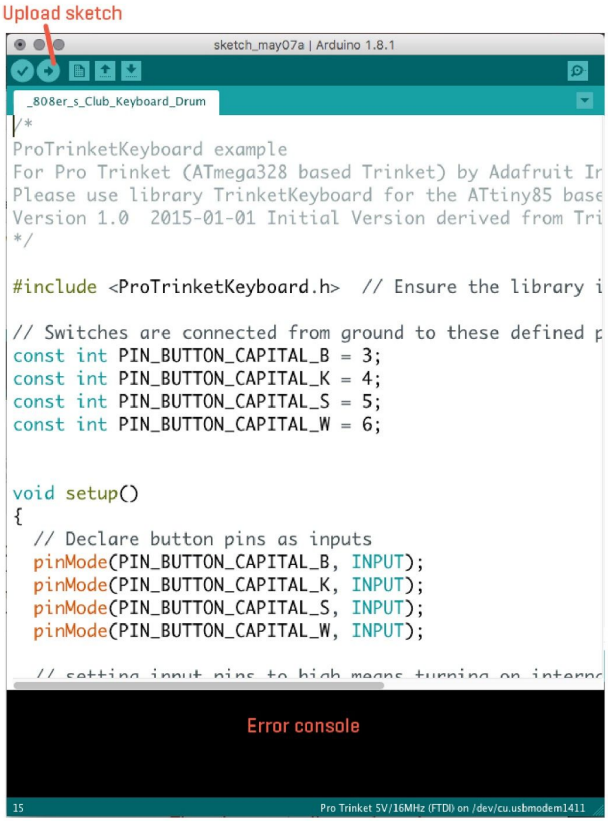


Explain code
We are telling our drum machine to act like a keyboard. Each touch point is assigned a letter. When the touch point is touched by the controller clip, the circuit will be closed and it will trigger a keypress. This will be useful for our Scratch code.*

15. Click the Verify button (checkmark) at the top of the window to make sure there are no errors (error messages will pop up in orange at the bottom of the window). If you receive errors, refer to the Troubleshooting section of the manual.

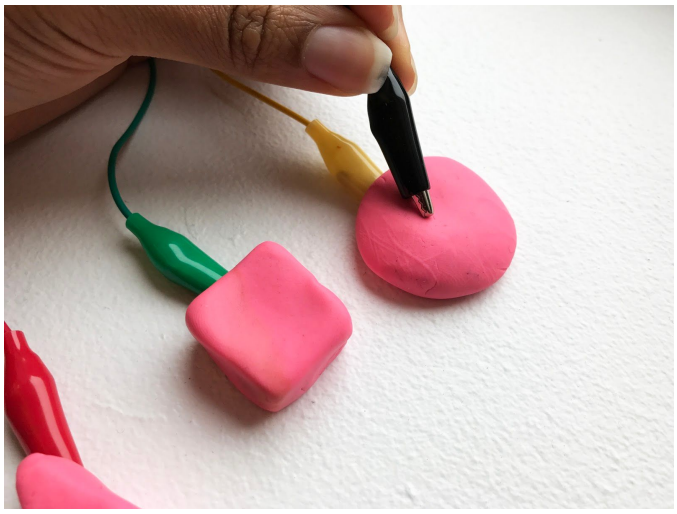


16. If there are no errors, press the reset button on the microcontroller and wait for the blinking red light microcontroller is blinking, click the Upload button (right arrow button next to the check mark button) in Arduino.



17. Go to tiny.cc/808ersclubdrum at access the Scratch project.

18. Test your instrument to see if sounds are being made when you tap the controller clip against the Play-Doh shapes.



Further Exploration:
"Can you add more touch points to your drum machine?"

Troubleshooting
"I'm getting errors in Arduino."

- Was every line of the code copied from the website and pasted into Arduino?
- Is the correct board selected?
    - Go to Tools → Board:... to make sure "Pro Trinket 5V/16MHz (USB)" is selected.
- Is the correct programmer selected?
    - Go to Tools → Programmer:... to make sure "USBtinyISP" is selected.
- Was the microcontroller in bootloader mode?
    - Press the reset button on the microcontroller and try to re-upload the code while the red light is blinking.
- Was the microcontroller plugged in?
- Was the correct port selected?
    - Go to Tools → Port. Select the last port on the list. If that doesn't work, try the other ports.

“My drum machine isn’t making noise.”

- Are you using the controller clip to touch the touchpads?
- Do you have the Scratch project open in the web browser?
    - Go to tiny.cc/808ersclubdrum to open the Scratch project.
- Are the wires pushed down all the way into the breadboard and the microcontroller?
- Are the components connected to the right places?
    - Go over the instructions step by step to make sure all of the connections are going to the right places.

“One of my touchpads isn’t working.”

- Check the connections to make sure the alligator clip is securely attached to the metal pin of the jumper wire.
- Make sure the jumper wire is connected to the correct pin on the microcontroller.
- Make sure the jumper wire is pushed all the way into the breadboard.

Clean up- 10 minutes

When it’s time to go, have everyone put their Play-Doh shapes back in the containers, and have students place their drum machines in plastic bags labelled with their name.

Review:

- What was your favorite part of the day?
- How does the drum machine work?
- What is a resistor?

Activity time: 60 minutes
Review time: 5 minutes
Clean up time: 10 minutes
TOTAL TIME: 1 hour, 15 minutes

Day 4- Composing a Song- 1 hour

Learning Objectives for the Day

Students will be introduced to:

- Sprites
- Tips/techniques for keeping rhythm and composing songs.

Deliverable for the Day

- A composed song (or alternative project) using the 808er's Club Drum Machine.

Supplies for the Day

- The 808er's Club Drum Machine from previous day.
- Desktop or laptop computer
- Scratch Drum Machine project: tiny.cc/808ersclubdrum
- Crafting supplies
    - Play-Doh
    - Aluminum foil
    - Paper
    - Pencils
    - Tape
    - Glue

Students have the chance to compose their own song. They can use the sounds provided to them on Scratch to create their song. This day can be used as an unstructured day, but there are opportunities to structure the time. The structure depends if the students seem comfortable with composing a song and exploring Scratch, or if they need more guidance. Encourage the students to not to be afraid to be creative. Here are some activities that can be done as a class if the students need more help composing (make sure to leave time for students to compose songs after doing the activities):

Pass the Rhythm: helps with rhythm
Have the students form a circle. One person, “the starter,” will start a rhythm (usually only 4 beats). The next person copies the rhythm while the original person makes up another. This keeps going until the starter gets their rhythm "back" (when the last person of the circle gets the rhythm.) When this happens, the starter claps 4 times, which signifies that the game is starting and the person who they first passed the rhythm starts the rhythm and passes it on.

Assembly Line: helps with composition and understanding Scratch
Students will set up their drum machines and picking a unique sound or rhythm from the sounds on Scratch. The student's sound choices should be recorded to make sure no know chose the same sound. Designate one student as the beat keeper. The beat keeper plays their sound continuously to keep the rhythm. Once the rhythm is set, you start the activity by pointing to a student. When the student is pointed at, they play their sound. The goal is to make a complex rhythm with all of the sounds and rhythms.

Faces: helps with rhythm
It's a mixture of dancing and tag. You can be a the beat keeper, or play an instrumental beat for the students to dance to. Have the students get into a circle. Each student comes up with a dance move. The first person steps into the middle of the circle, does their dance move for 16 counts (you can count to make sure the timing is right), then tags someone else in. The next person does their own dance move, does the previous person’s move, and tags someone else in.

Students can also do any of the following tasks:

Use sounds from external sources (e.g., YouTube)

- To edit the Scratch code, click See Inside.
- Click on the sprite whose sound you would like to change.
- To select a new sound, click the dropdown menu on the purple block that says “play sound.”
- Test the sound by tapping the corresponding touchpoint.

Add more touchpads to drum machine
Change construction of drum machine

- Use different conductive materials for the touchpads.
    - Examples: aluminum foil, coins, pencil lead, etc.

Collaborate with their peers to create a song.

Have students write down the sequence of their song so they won’t forget how to play it when performance time comes. They can use this as “sheet music” while they are performing.

Activity time: 60 minutes
Clean up time: 10 minutes
TOTAL TIME: 1 hour, 10 minutes

Day 5- Performance Day

Objective for the Day

Students will:

- Perform a song (or demonstrate an alternative project) using their drum machine.

Supplies for the Day

- The 808er's Club Drum Machine.
- Scratch Drum Machine project (http://tiny.cc/808ersclubdrum)
- Desktop or laptop computer
- Speakers

Student explain how they created their drum machines and perform their compositions.

Clean up- 10 minutes

Instruct the students to pack up their drum machines. They can choose to take the components apart or leave them connected. This is when the students get to take home the components. Direct students to the 808er's Club website to access more physical computing activities at home.

Activity time: 60 minutes, or until students are finished presenting
Clean up time: 10 minutes
TOTAL TIME: 1 hour, 10 minutes

What can students do after the Workshop?

You can find more activities and learn how to setup Arduino at home here: 808ersclub.com/activities.

Activity	Description	Difficulty
 Lo-Fi Electronic Music	Use code to create simple songs that play from a piezo buzzer.	Easy
 Real Instruments	Use drum machine configuration with other Scratch projects (piano, drum, guitar).	Intermediate
 Frequency + Touch Sensing	Frequency of buzzer changes when resistance changes.	Intermediate

Real Instruments

Using the same configuration as the 808er's Club Drum Machine to play other Scratch instruments—a piano, drum set, and guitar.

Level of Difficulty: Easy

Supplies:

- The 808er's Club Drum Machine kit
- Desktop or laptop computer

Instructions

If you need to rebuild and reprogram the 808er's Club Drum Machine, follow the instructions provided here: 808ersclub.com/drum-machine-tutorial.

1. You can choose which instrument you want to play on Scratch:
    a. Piano: tiny.cc/808ersclubpiano
    b. Drum set: tiny.cc/realdrum
    c. Guitar: tiny.cc/808ersclubguitar
2. Use the controller clip to tap the touchpads

Lo-fi Electronic Music

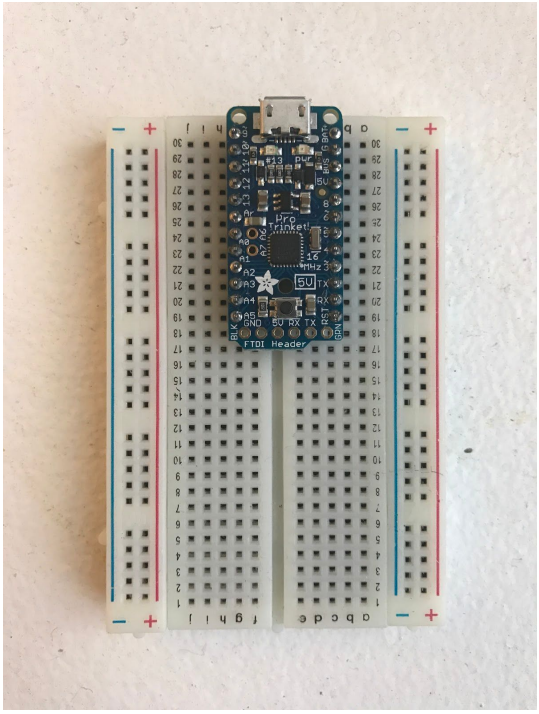
In the code, each note in the song is a frequency, which is measured in hertz. Arduino plays the frequency through the piezo buzzer. The notes can be play for long or short amounts of time within Arduino using the noteDurations array (range of numbers). We also have to tell Arduino how many notes it's supposed to play, so however many notes are in the song, that number goes in the "length of song" for loop.

Supplies:

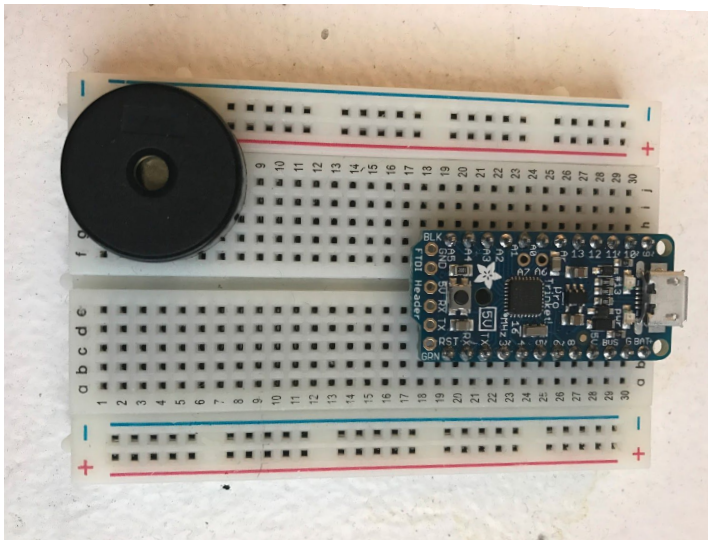
- microcontroller with USB cable
- piezo buzzer
- 2 jumper wires
- Breadboard
- Desktop or laptop computer
- Arduino IDE software

Instructions:

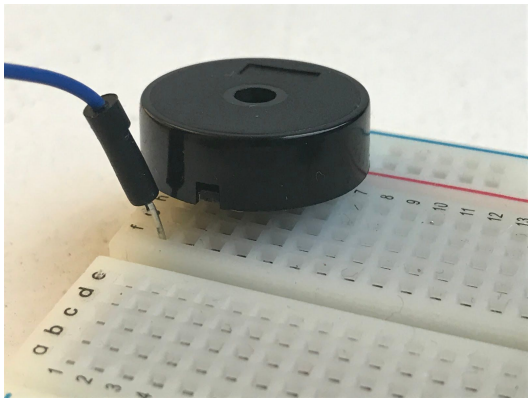
1. Plug microcontroller into the middle of the breadboard, leaving room for the piezo buzzer and jumper wires to fit in the same rows as the pins.

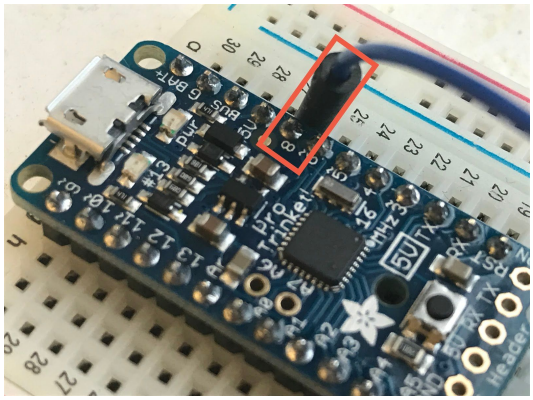


2. Plug the piezo to the breadboard (leave space on the rows for the jumper wires to fit).

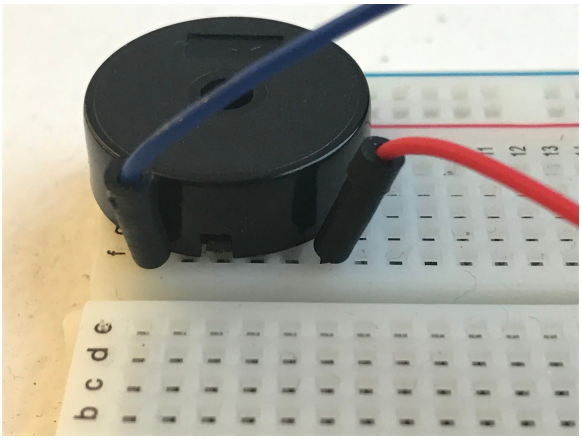


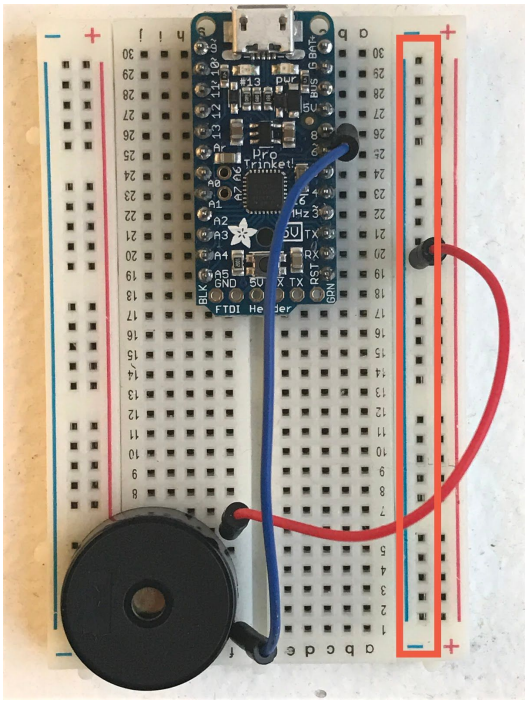
3. On the same row as one of the legs of the buzzer, connect a jumper wire. Plug the other end of the wire into the same row on the breadboard as the “8” digital pin of the microcontroller.





4. One the same row as the other of the leg of the buzzer, connect a jumper wire. Plug the other end of the wire into the same row on the breadboard as the “G,” or Ground pin of the microcontroller (think of G as the negative pole).

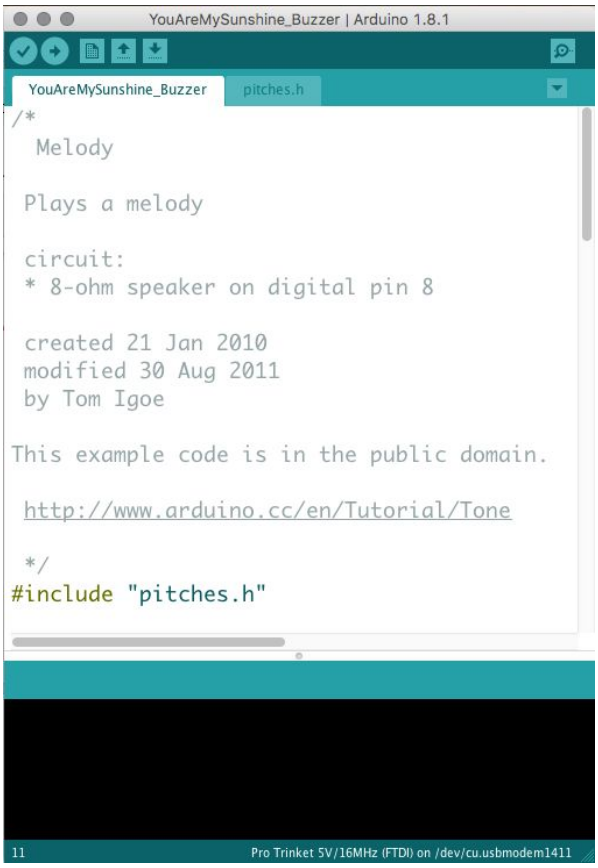




5. Plug one end of the USB cable into the microcontroller. Plug the other end of the cable into the USB port on the computer.

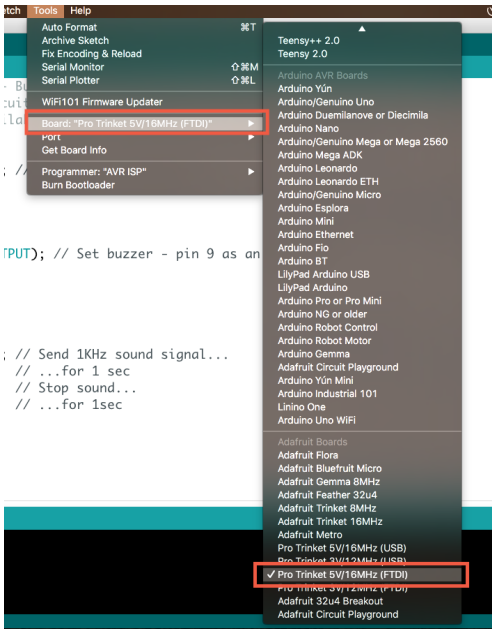
6. Go to 808ersclub.com/lofi-electronic-music to download the code for the buzzer songs. There are four songs to choose from under the Supplies section.

7. Open the Arduino file you downloaded.

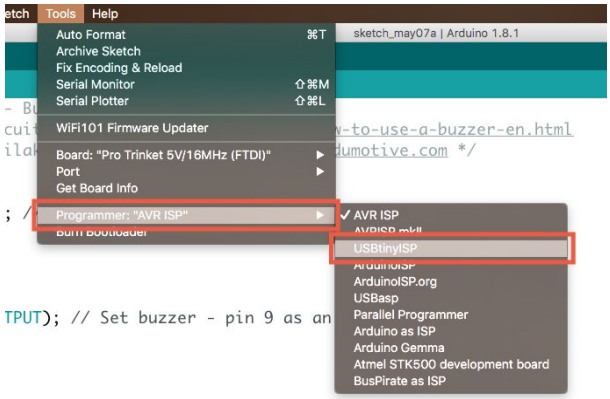


8. On the menu bar at the top of the screen, go to Tools -> Board:

9. Select “Pro Trinket 5V/16MHz (USB).”

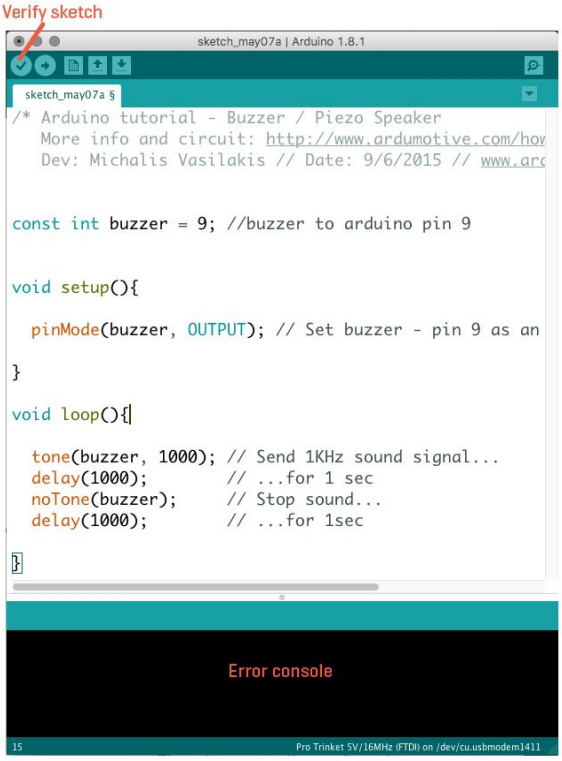


10. On the menu bar at the top of the screen, go to Tools -> Programmer:

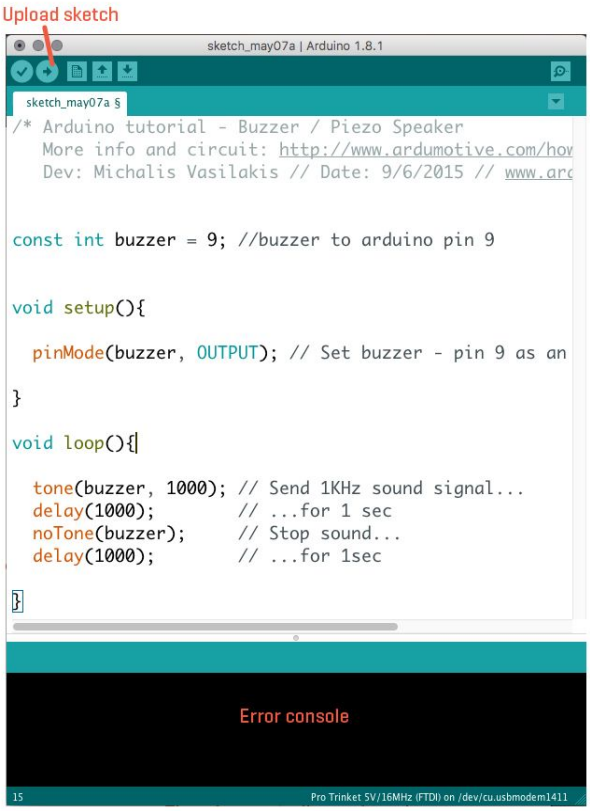


11. Select “USBtinyISP.”

12. Click the Verify button (checkmark) at the top of the window to make sure there are no errors (error messages will pop up in orange at the bottom of the window).



13. If there are no errors, click the Upload button (right arrow).



Further Exploration

- Can you add an LED to the circuit to match the rhythm of the tune?
- Can you make a switch to open and close the circuit?
- Can you create a different song?

Frequency + Touch Sensing

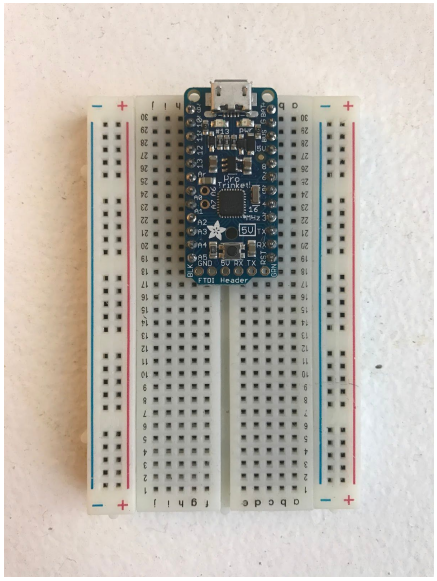
Change the frequency that the buzzer outputs by changing the resistance within the circuit. When you stretch or contract the Play-Doh, you should hear the frequency of the buzzer change. If you are using aluminum foil instead of Play-Doh, you will hear the frequency change when you open and close the circuit. Example from University of St. Thomas.

Supplies:

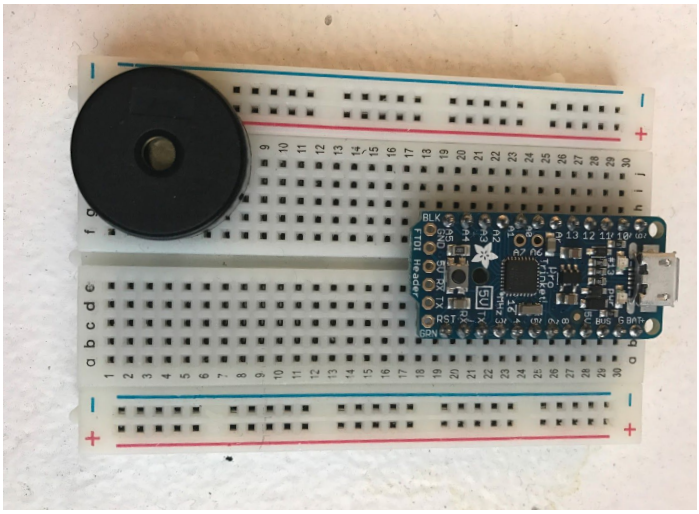
- Microcontroller with USB cable
- Breadboard
- Piezo buzzer
- Play-Doh (or aluminum foil)
- 1 Resistor (470 ohm)
- 5 jumper wires
- 2 Alligator clips (if you are using aluminum foil)

Instructions

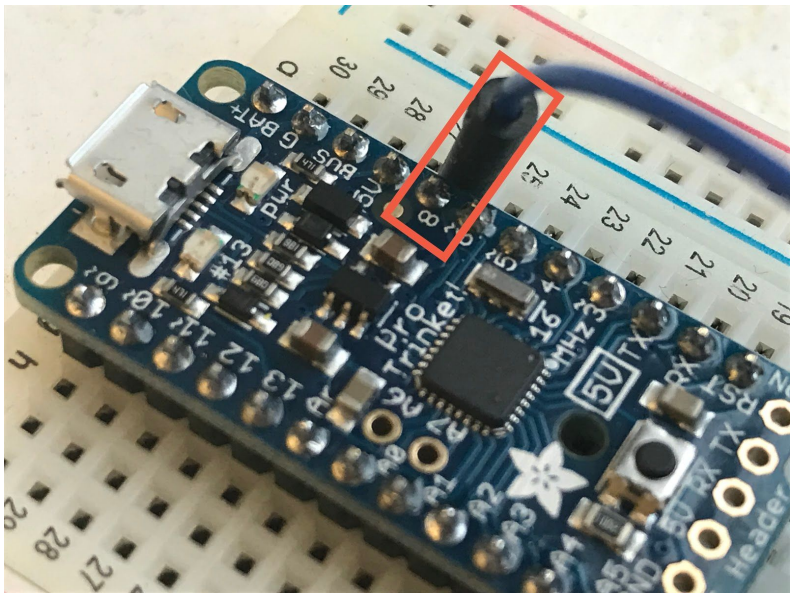
1. Plug microcontroller into the middle of the breadboard, leaving room for the piezo buzzer and jumper wires to fit in the same rows as the pins.



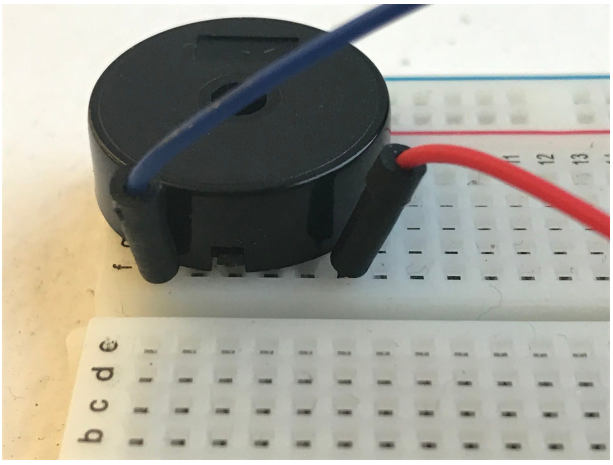
2. Plug the piezo to the breadboard (leave space on the rows for the jumper wires to fit).

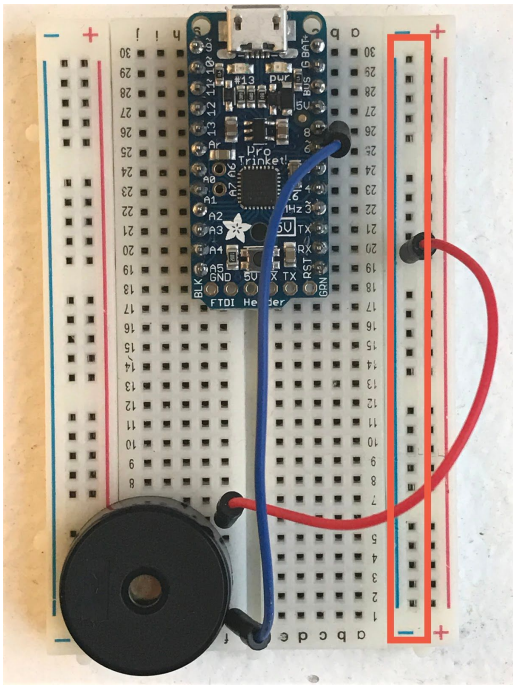


3. On the same row as one of the legs of the buzzer, connect a jumper wire. Plug the other end of the wire into the same row on the breadboard as the “8” digital pin of the microcontroller.

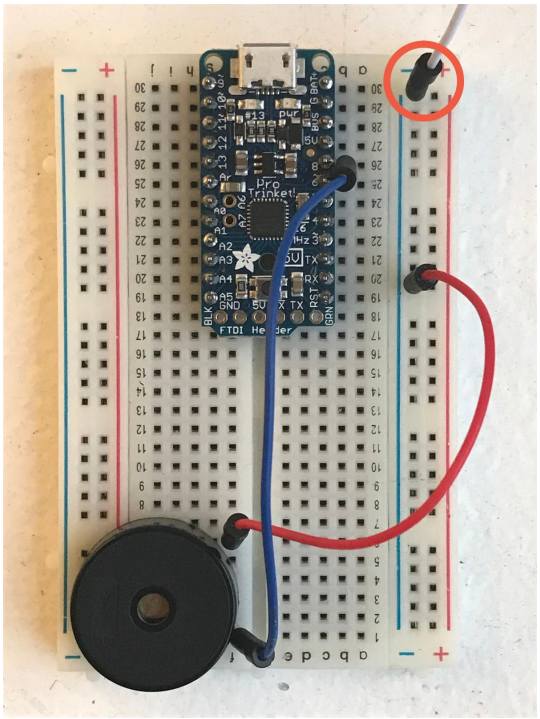


4. One the same row as the other of the leg of the buzzer, connect a jumper wire. Plug the other end of the wire into a hole on the long blue rail on the side of the breadboard.

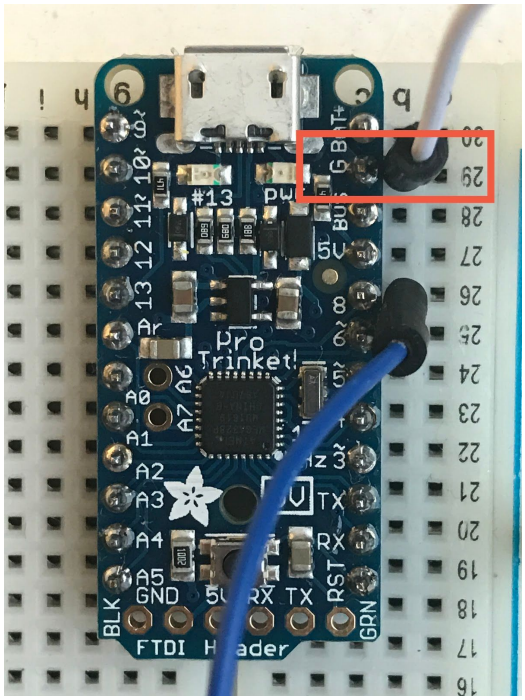




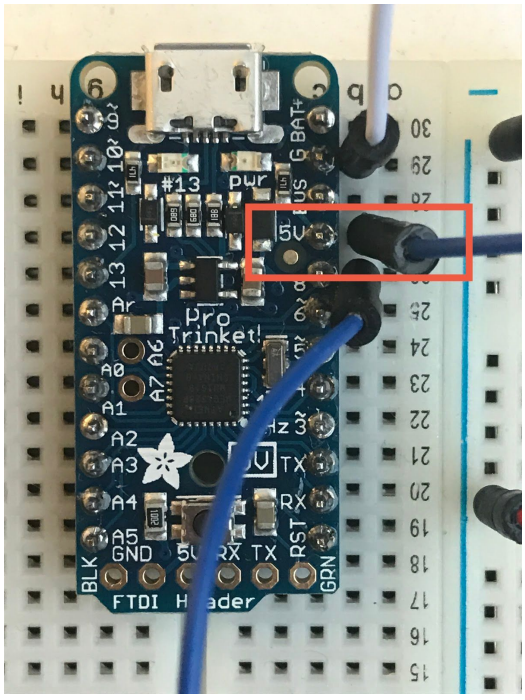
5. Take another wire and plug one side into another hole on the blue rail of the breadboard.



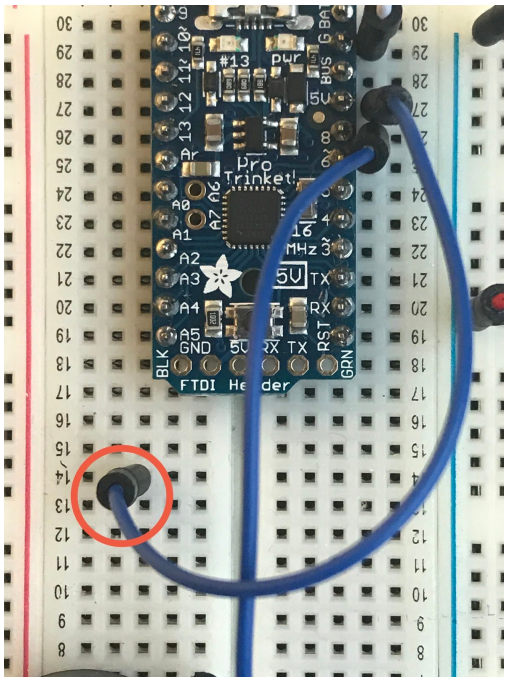
6. Plug the other end into the same row on the breadboard as the “G,” or Ground pin of the microcontroller.



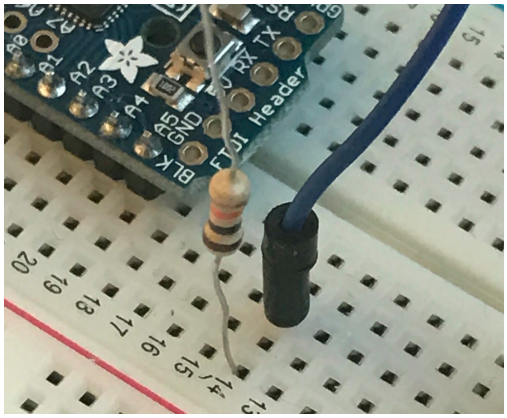
7. Plug a new wire into the same row on the breadboard as the 5V pin on the microcontroller.



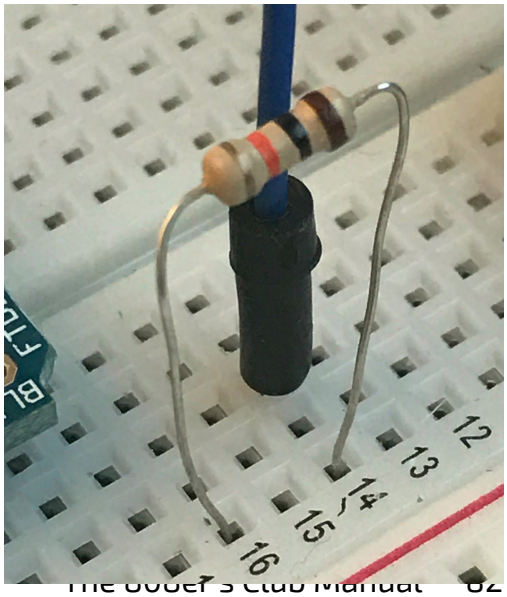
8. Plug the other end into an empty row on the breadboard.



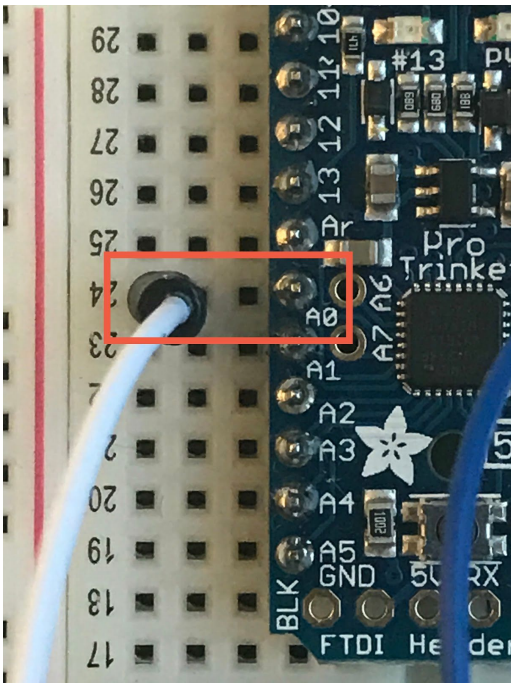
9. Take the resistor and plug one leg into the same row as the wire going to 5V.



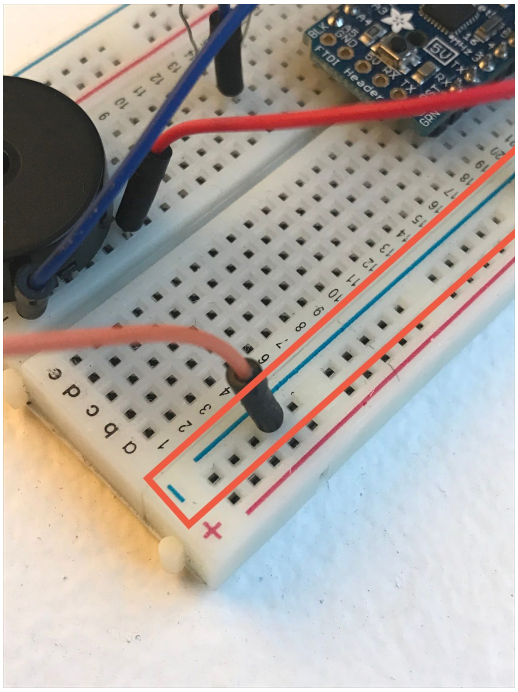
10. Plug the other leg of the resistor into an empty row on the breadboard.



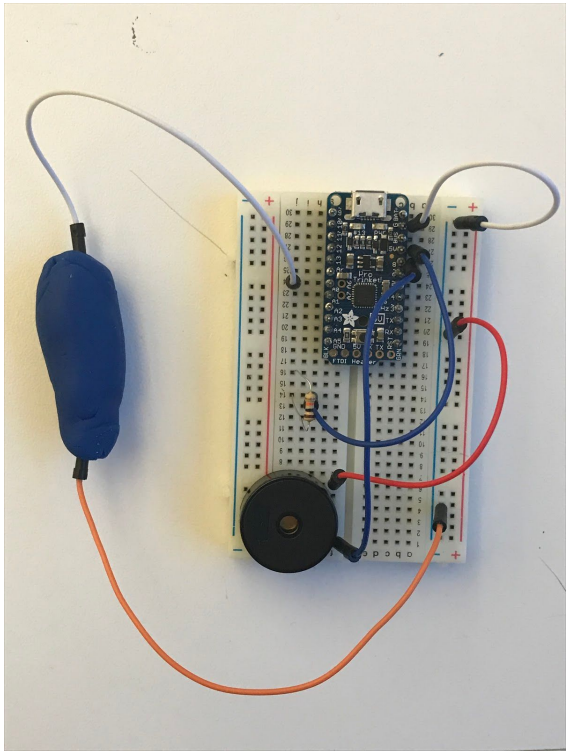
11. Grab a new wire and plug it into the same row on the breadboard as the A0 pin on the microcontroller.



12. Take a new wire and plug one side into a hole on the blue rail of the breadboard.



13. Grab a hunk of Play-Doh (or a sheet of aluminum foil—the effect is heard better using Play-Doh), and push the free ends of the A0 and ground wires into the Play-Doh.
    If you are using aluminum foil instead of Play-Doh, attach one side of an alligator clip to the A0 wire, and the other side to the aluminum foil sheet. Then attach another alligator clip to the free Ground wire and the other end to the aluminum foil.

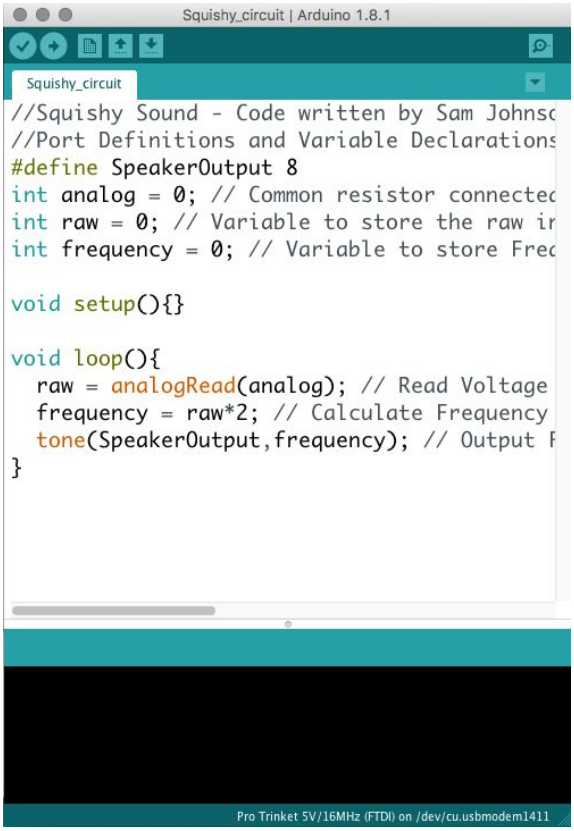


14. Take the free end of that G wire and push it into the other side of the Play-Doh. If you are using aluminum foil, attach one side of an alligator clip to the G wire, and the other side to the aluminum foil sheet.

15. Go here to copy the Arduino code: 808ersclub.com/frequency-touch.

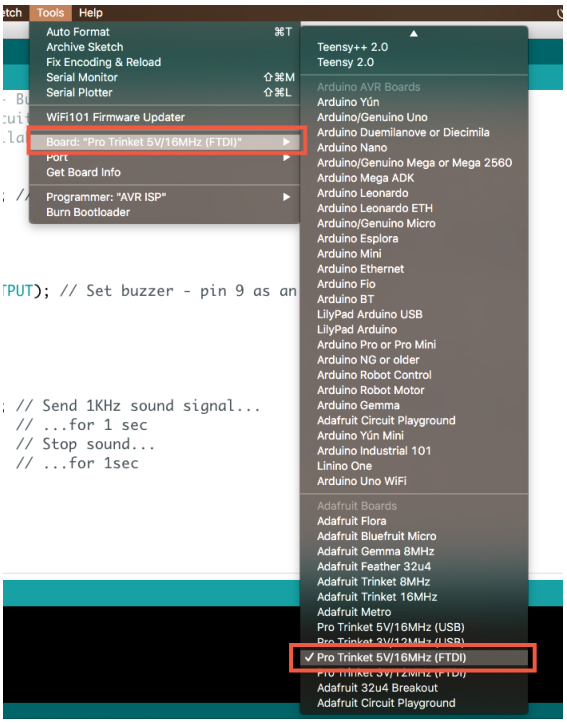
16. Open Arduino.

17. Paste the code into the Arduino IDE.

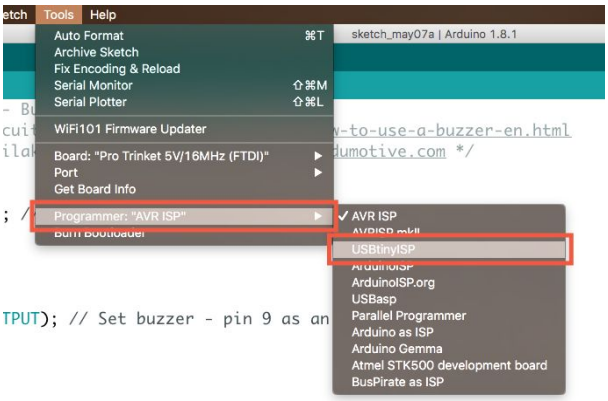


18. On the menu bar at the top of the screen, go to Tools -> Board:

19. Select “Pro Trinket 5V/16MHz (USB).”

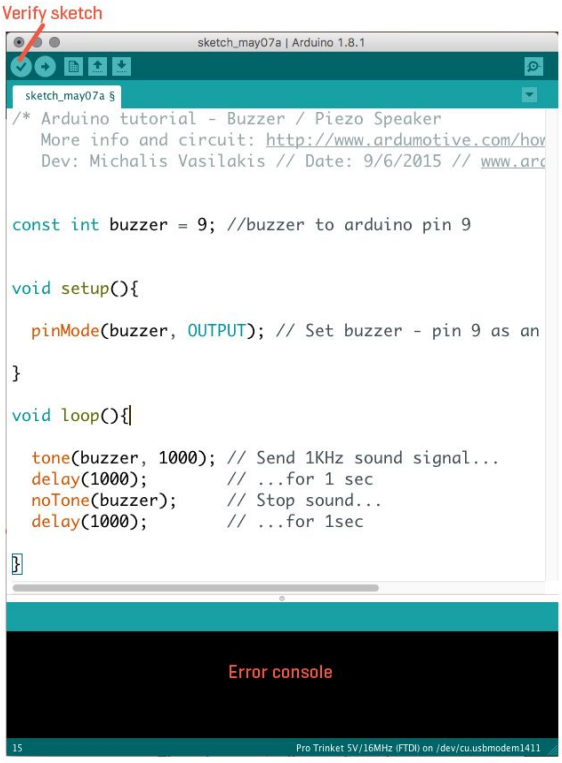


20. On the menu bar at the top of the screen, go to Tools -> Programmer:

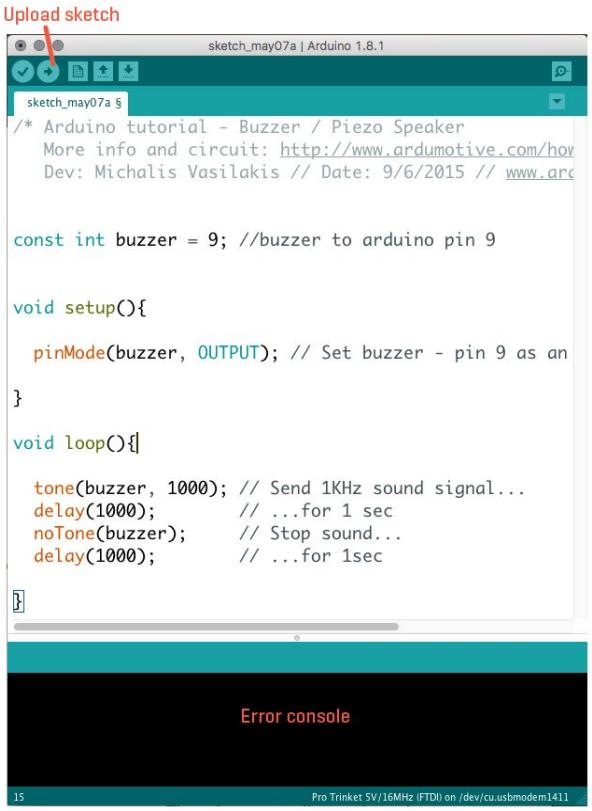


21. Select “USBtinyISP.”

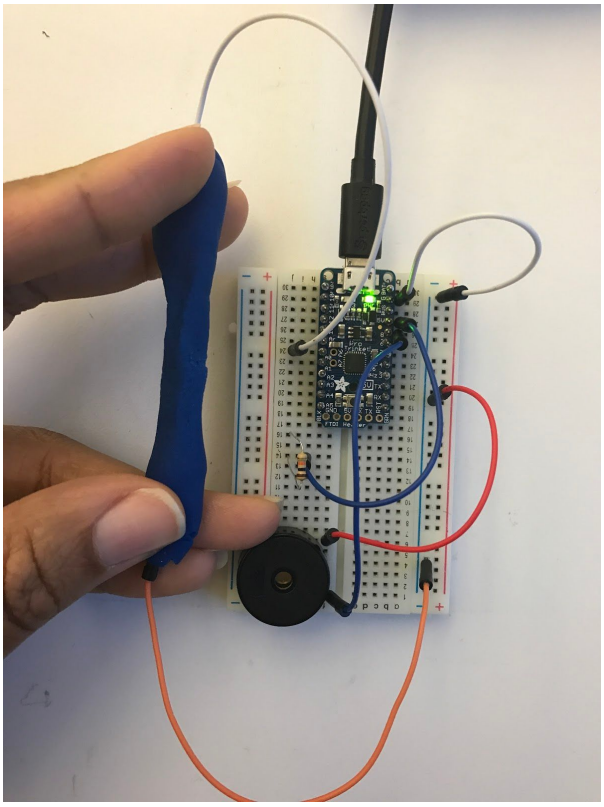
22. Click the Verify button (checkmark) at the top of the window to make sure there are no errors (error messages will pop up in orange at the bottom of the window).



23. If there are no errors, click the Upload button (right arrow).



24. Stretch the Play-Doh to hear the frequency of the buzzer change. If you're using aluminum foil, detach an alligator clip from the aluminum foil to hear the frequency change.



Glossary

808- The Roland TR-808 Rhythm Composer, more commonly referred to simply as the 808, is a drum machine created by the Roland Corporation in 1980. It has preloaded track on the machine that can be looped in any sequence. It allows the user to record their sequence and play it back. It could also be programmed with different tracks. It revolutionized how many genres made music, especially Hip-hop.

Analog pin- A pin on a microcontroller that receives information with an infinite (unlimited) number of possible values from input devices. Example: a range from 1 to 200 can have values such as 2, 54, 199.2 or 199.2375.

Arduino IDE software- The Arduino Integrated Development Environment—or IDE—is software that is used to connect to some microcontrollers and allows users to write code, upload programs, and communicate with them.

Breadboard- Also known as a solderless breadboard, is a board for making an experimental model of an electric circuit. Circuits can be created without having to permanently bond components together.

Circuit- The pathway that electrical current flows through.

Closed circuit- A circuit that allows electricity to flow to all parts without interruption.

Code- Written instructions for a microcontroller.

Conductor- Material that allows electricity to flow from place to place. The electrons of a conductive material are held loosely together, which allows electrons easily move from one atom to another. Examples: copper wires, aluminum foil, Play-Doh, pencil lead.

Digital pin- A pin on a microcontroller that sends or receives data with a finite {limited) number of possible values from input or output devices. Example: the microcontroller can send an output device either a value of 0 or 1.

Electrical current- The movement of electrons from atom to atom.

Electron- A particle found in atoms with a negative charge of electricity.

Ground- The base voltage to compare all other voltages in the circuit. It is a part of the circuit where the electricity completes the circuit and returns back to the power source. Think of it as the opposite of the power source because the power source send out power. Ground receives the power.

Hardware- the physical object that is used to interact with software.

Input device- An accessory or attachment used to send information and signals to a microcontroller.

Insulator- Material that does not allow electricity to flow from place to place. The electrons of an insulators are held tightly together, which restricts electrons from easily jumping from atom to atom. Examples: wood, paper, cloth, rubber.

Light-emitting diode (LED)- A device that gives off light when an electric current passes through it. The positive side of the LED is called the “anode” and it is the long “lead,” or leg. The other, negative side of the LED is called the “cathode.” An LED is a type of load.

Load- The part of a circuit that is being powered. Example: light bulb.

Microcontroller- A single-purpose computer. It contains memory, input/output devices, as well a processor. Microcontrollers process information from code and perform commands specified by the code.

Open circuit- An incomplete circuit, where the flow of electricity is interrupted.

Output device- An accessory or attachment used to receive information and signals from a microcontroller.

Parallel circuit- A closed circuit where the electrical current is divided into two or more paths and then returns along a common path to complete the circuit.

Piezo buzzer- An audio output device. It is serves as a load in a circuit.

Polarity- (positive pole and negative pole) The direction of current flow in a circuit.

Power source- The part of a circuit that provides energy (voltage) to a load. Where electrical current leaves the power source is positively charged. Examples: battery, wall outlet.

Proton- A particle found in atoms with a positive charge of electricity.

Resistance- The measure of how tightly a material is holding electrons together. Resistance is measured in ohms (Ω) Example: wood has a higher level of resistance than metal because wood is an insulator, meaning its electrons are held tightly together.

Resistor- A component in a circuit that limits the flow of electricity.

Scratch- A free programming language and online community. It is a visual way of coding. It allows you to drag and drop blocks to create commands.

Series circuit- A circuit in which current has only one path to take.

Short circuit- A circuit where the current travels along an unintended path. Example: if wires in a circuit accidentally touch in front of the load, electricity will never reach the load because the circuit closed in front of the load.

Software- includes computer programs, applications, and sets of instructions (code).

Sprite- A computer graphic that moves and is treated as an individual object.

Switch- creates a gap in the circuit. It either stops electricity from flowing or continues the flow of electricity. Examples: push button, light switch, toggle switch.

Voltage- The electric pressure from a power source that moves electrons from one atom to another. A volt is the measure of electric pressure.

About the Creator of the 808er's Club

Bio

My name is Alexis Caudle. If you asked me what I was going to be when I grew up, I would have told you I would be a street artist. Although I don't sell my work on the street, I am still a creator. I always knew I was going to be a creator. I channeled that passion into an interest in graphic design. I majored in graphic design at Old Dominion University in Norfolk, Virginia. I was surrounded by wonderfully talented visual artists, but I noticed that few of them looked like me. I was one of few Black students in my undergraduate program, and the only Black woman to graduate from that program in my class.

Later on, I decided to go to graduate school to explore more creative avenues. I majored in Design in Technology at The New School in New York City. I was again surrounded by brilliant creative minds. However, yet again, I was also one of few Black students in program. It didn't take me long to see a pattern within design and technology programs. This is what prompted me to create The 808er's Club as my graduate thesis project.

I am interested in technology education. I love breaking down complex concepts into digestible bits of information, and thinking of real-world application for that information. I believe this is basis of learning. I also enjoy visual design—it's one of the primary means of expression I use.

Contact

You can find me on the interwebs:

@alexisacaudle .../alexisacaudle .../in/alexis-caudle

Appendix

Worksheets

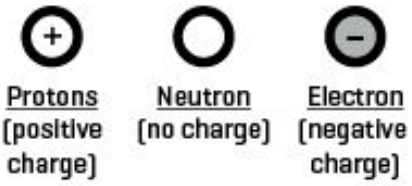
1. Electricity
2. Types of Circuits
3. Microcontroller
4. Breadboard

Resources

Bibliography

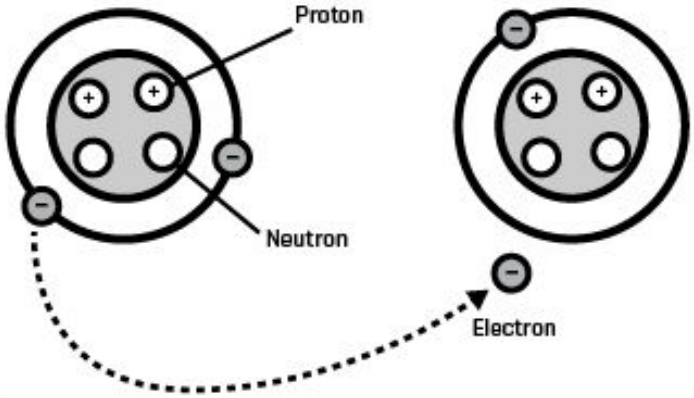
Electricity and Circuits

Electricity involves 3 tiny particles...



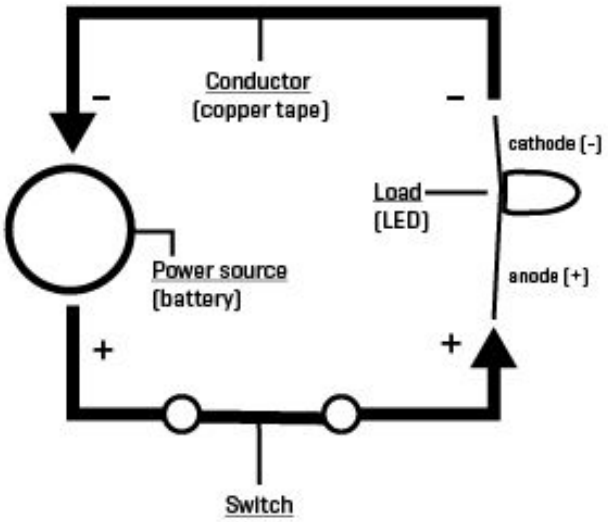
Protons (positive charge) | Neutron (no charge) | Electron (negative charge)

The flow of electricity is called electrical current, which is the flow of electrons from atom to atom.



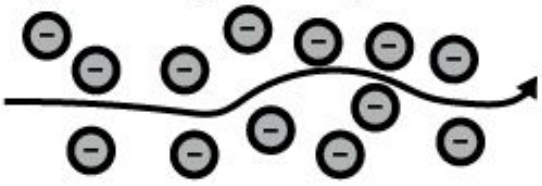
Circuits are the paths that electrical current flows through.

Circuits are made of 4 main components: power source, conductor, load, switch.



Some materials are better at allowing electrical current to flow than others.

Conductors allow electrical current to flow through them. They have loosely held electron.

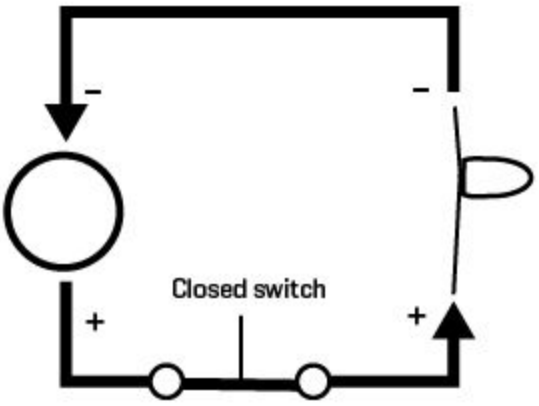


Most metals are good conductors.

Insulators do not allow electrical current to flow through them. They have loosely held electron.

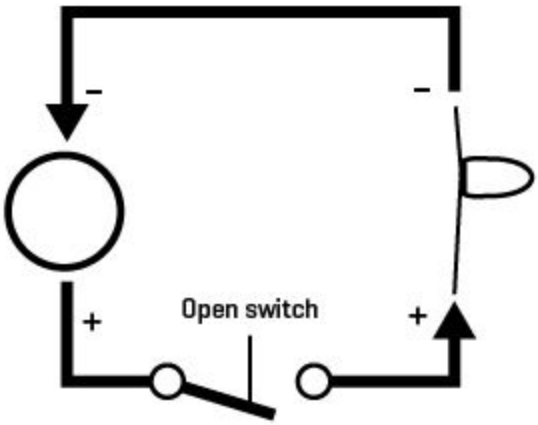
Rubber, plastic, cloth, and paper are insultors.

Types of Circuits

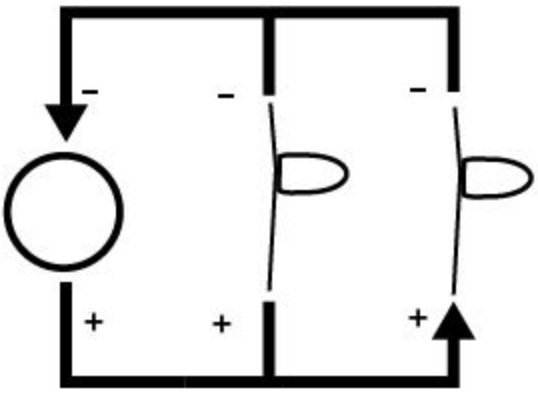


Our goal is to build a circuit that flows to all of the parts of the circuit without interruption. We want to make a closed circuit.

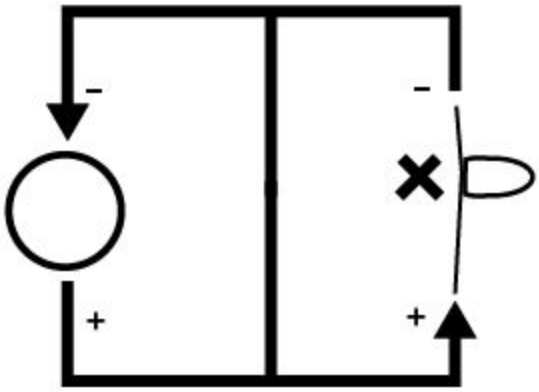
This circuit is also considered a series circuit because the electrical current has only one path to take.



An open circuit is an incomplete circuit, where the flow of electricity is interrupted.



A parallel circuit is where the electrical current is divided into two or more paths and then returns to ground along a common path to complete the circuit.



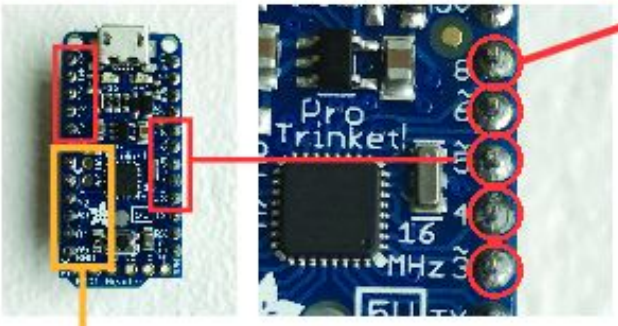
A short circuit is when electricity in a circuit travel along an unintended path. The electrical current does not flow to all of the parts of the circuit. In the example above, the LED will take the shortest path back to ground (negative).

Microcontrollers

A microcontroller is a single-purpose computer. Microcontrollers do one thing. They contain a processor core (like the brain), memory, and input/output devices (attachments, accessories).

Input devices are accessories or attachments that **receive** info **from** the microcontroller.
Output devices are accessories or attachments that **send** info **to** the microcontroller.

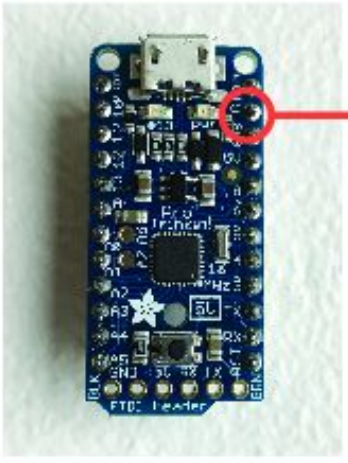
There are pins on the microncontroller that connect input and output devices to the microcontroller. There are two types of pins:



Digital pins
Sends or receives data with a limited number of possible values from input or output devices.

5 volts pin
Provides power to accessories.

Analog pin
Receives information with an infinite number of possible values from input devices. On a microcontroller, they are usually marked as A0, A1, A2, etc.



Ground pin
A part of the circuit where the electricity completes the circuit and returns back to the power source. Think of it as the opposite of the power source because the power source send out power. Ground receives the power.

Breadboards

Breadboards allow you to create circuits without having to permanently bond components together. The breadboard connects components together in two different ways:

Back of breadboard

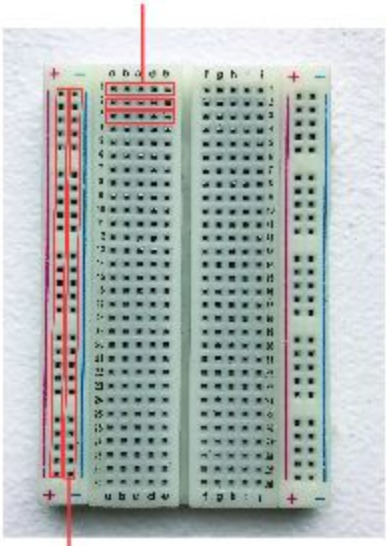
Each rail or row is connected together by a strip of metal.

Single row

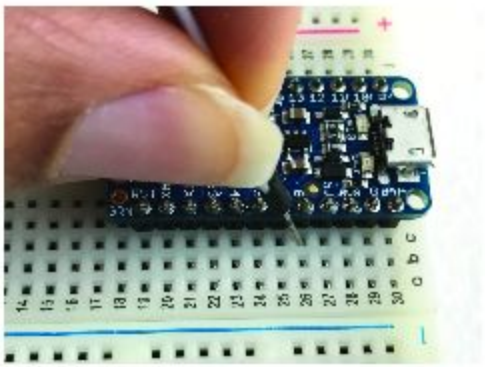
Single column

Front of breadboard

Any hole on in the same row is connected; so if two wires are plugged into the same row, they will be connected.



The negative and positive rails on the side of the breadboard link components together. They are connected together by column, not row.



How the microcontroller fits on the breadboard

Resources

How electric circuits work
discoverykids.com/articles/how-do-electric-circuits-work/

How does the microcontroller work?
cdn-learn.adafruit.com/downloads/pdf/adafruit-arduino-lesson-1-blink.pdf

Arduino Reference
arduino.cc/en/Guide/HomePage

What are conductors and insulators?
ny.pbslearningmedia.org/resource/phy03.sci.phys.mfe.zcircuit/exploring-conductivity-kid-circuits/

Building a Piezo Buzzer Circuit using a Microcontroller
learn.sparkfun.com/tutorials/sik-experiment-guide-for-arduino---v32/experiment-11-using-a-piezo-buzzer

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    b. Mariachi Hero Grande, which features a "bandito" character that stereotypes Mexican culture. The protagonist in I-Immigrate is a anamorphic rat named El Queso whose goal is to cross the border while being chased by cops.
    Perez, Damarys Ocaña. "Apple's 5 Most Racist IPhone Applications." Latina. March 04, 2011. Accessed October 04, 2016. http://www.latina.com/lifestyle/-news/apples-5-most-racist-iphone-applications.

    c. An algorithm Google uses to categorize photos that labeled a photo will two Black people in it as "gorillas."
    Mulshine, Molly. "A major flaw in Google's algorithm allegedly tagged two black people's faces with the word 'gorillas'" Business Insider. July 01, 2015. Accessed April 29, 2017. http://www.businessinsider.com/google-tags-black-people-as-gorillas-2015-7.

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