

Integration of Robotics (Arduino) and Coding into Grade 9 Science (applied and academic)

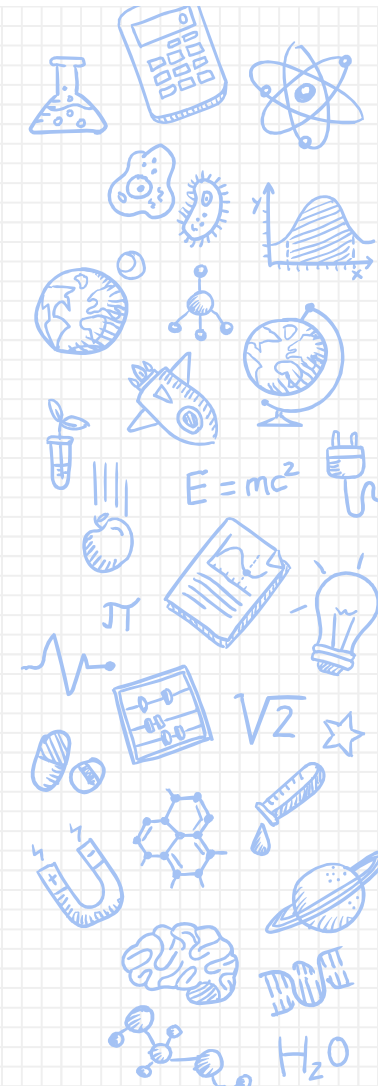
STAO Technology Enabled Learning (TEL) Project



MAIN FOCUS

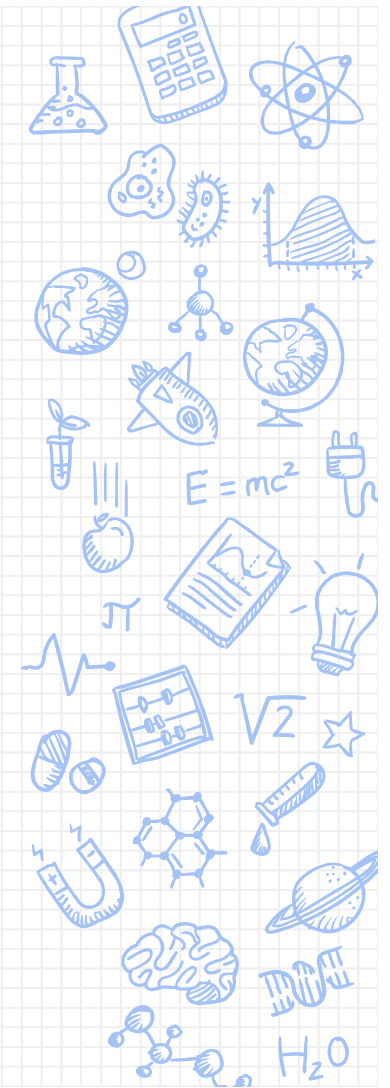
The purpose of these lessons is to integrate robotics (microcontrollers such as Arduino boards) and computational thinking/coding within the grade 9 science curriculum.

As all students take grade 9 science, we can provide students with an opportunity to connect automation, coding, and robotics to the study of science. (STEM careers)



To provide students with the opportunity to make connections to the science, technology, engineering, and economic sectors and career pathways of robotics.

To provide an opportunity for teachers and students to co-learn through inquiry based learning, and use critical thinking approaches.



Prior Skill Sets – coding and robotics

- ✘ No previous experience with coding or robotics is required for this series of lessons.
- ✘ However, it would be beneficial to survey your class to see which students have experience with building robots, coding, or both.
- ✘ More and more elementary students are being exposed to it through their teachers; extra-curricular activities; or clubs they belong to outside of school.





CURRICULUM CONNECTIONS

Grade 9 Applied Science - SNC1P
Grade 9 Academic Science - SNC1D

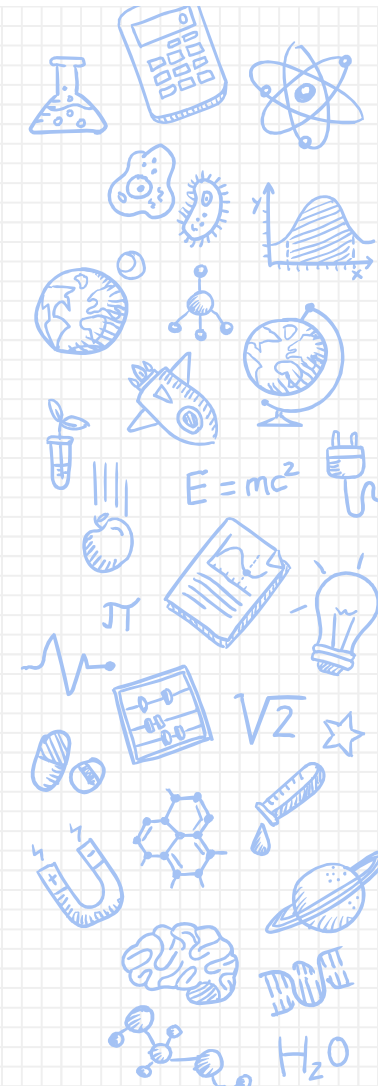
Big Ideas – SNC1P

Physics

- ✘ Static and current electricity have distinct properties that determine how they are used

Earth and Space Science

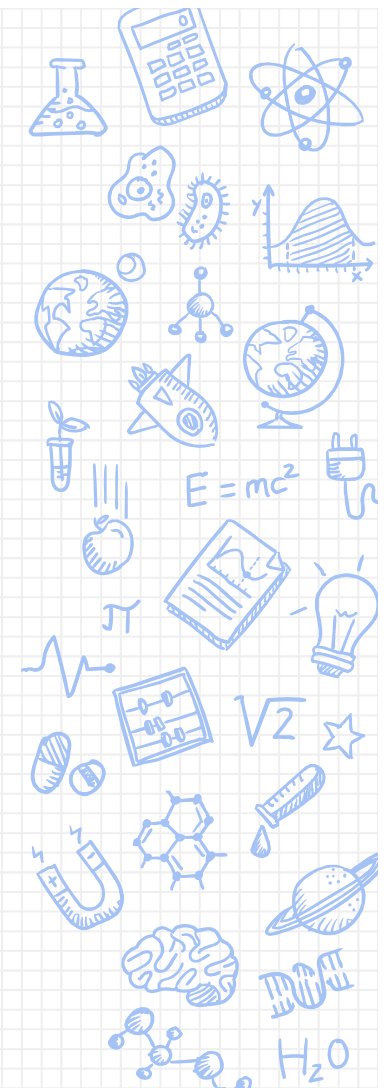
- ✘ Technologies developed for space exploration have practical applications on Earth



Ministry Expectations – SNC1P

Physics: Electrical Applications

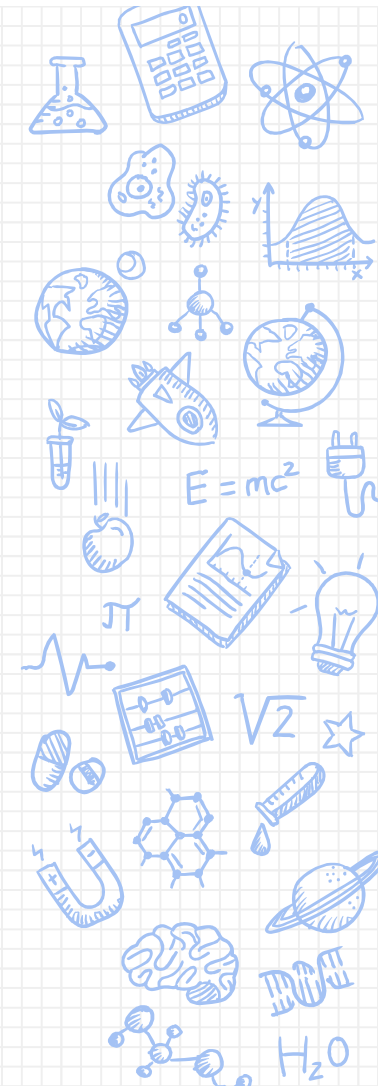
- ✘ E2.4 – design, draw circuit diagrams of, and construct simple series and parallel circuits
- ✘ E2.5 – compare, on the basis of observation, the differences between series and parallel circuits
- ✘ E3.3 – identify the components of a simple direct current electrical circuit, and describe their functions
- ✘ E3.7 – explain the practical use of resistance in a common household product



Ministry Expectations – SNC1P

Earth and Space Science: Space Exploration

- X D1.1 - research the challenges associated with space exploration, and explain the purpose of materials and technologies that were developed to address these challenges and how these materials and technologies are now used in other fields of endeavour
- X D2.4 - investigate a technological challenge related to the exploration of celestial objects that arises from the objects' specific properties, and identify the solution that has been devised



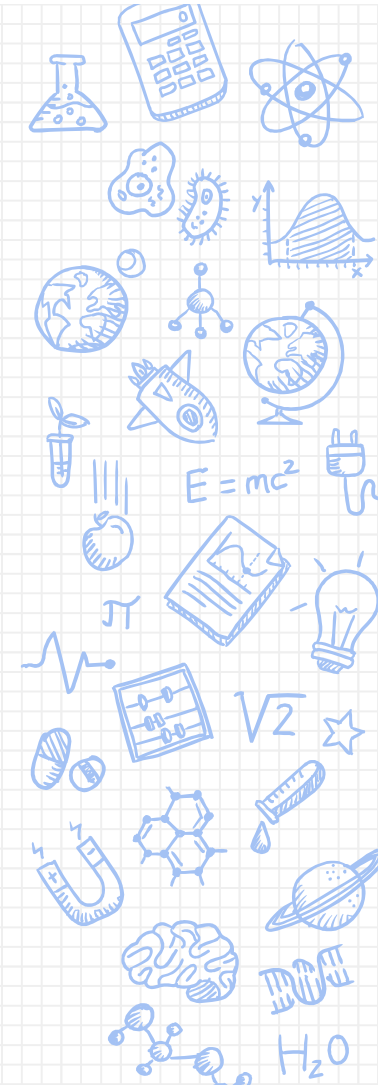
Big Ideas – SNC1D

Physics

- ✕ Static and current electricity have distinct properties that determine how they are used

Earth and Space Science

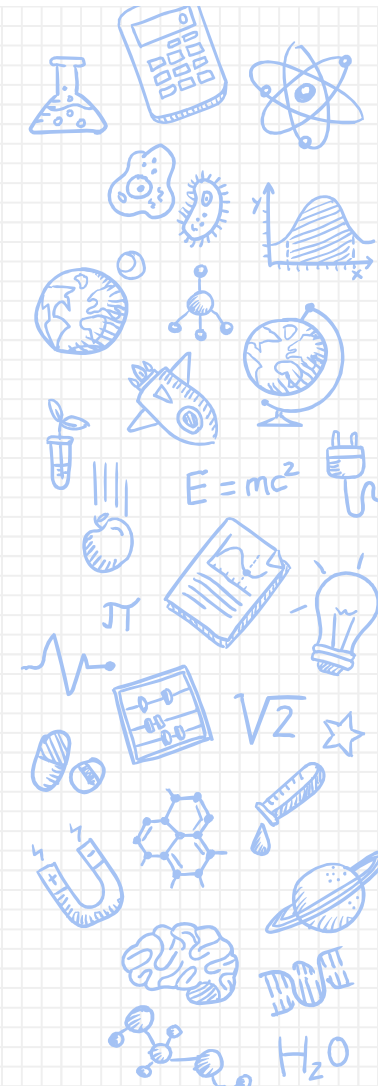
- ✕ Space exploration has generated valuable knowledge



Ministry Expectations – SNC1D

Physics: The Characteristics of Electricity

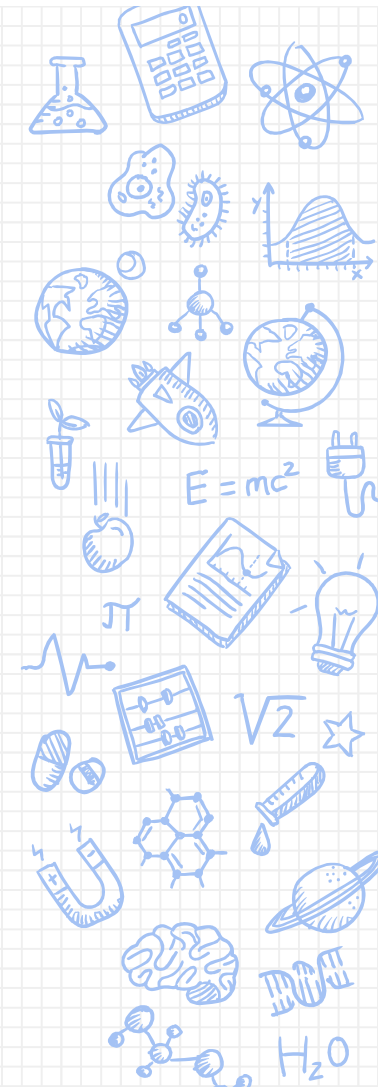
- ✘ E2.5 – design, draw circuit diagrams of, and construct simple series and parallel circuits
- ✘ E2.6 – analyse and interpret the effects of adding an identical load in series and in parallel in a simple circuit
- ✘ E3.4 – identify the components of a simple DC electrical circuit, and explain their functions



Ministry Expectations – SNC1D

Earth and Space Science: The Study of the Universe

- X** D1.2 - assess some of the costs, hazards, and benefits of space exploration, taking into account the benefits of technologies that were developed for the space program but that can be used to address environmental and other practical challenges on Earth



Prior Skills Sets – from the science curriculum

Grade 6 Science and Technology

Electricity and Electrical Devices

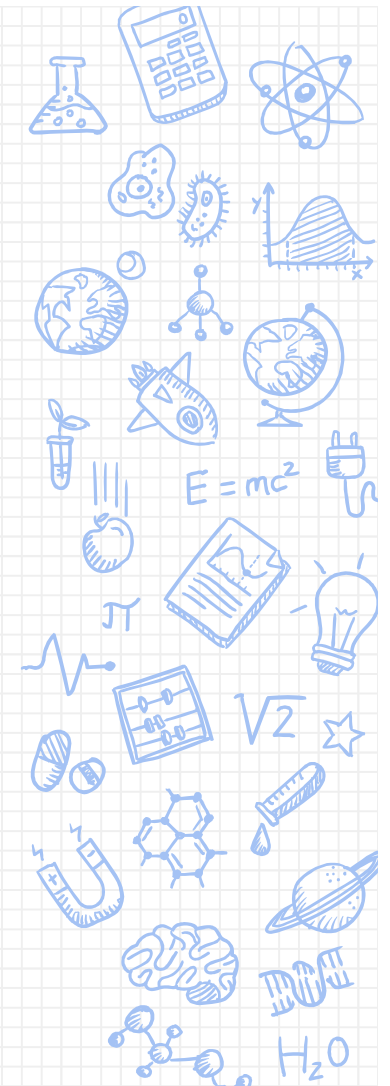
- ✗ design and build series and parallel circuits, draw labelled diagrams identifying the components used in each, and describe the role of each component in the circuit

Space

- ✗ identify the technological tools and devices needed for space exploration

Grade 8 Science and Technology: Systems in Action

- ✗ Systems are designed to accomplish tasks
- ✗ All systems include an input and an output.



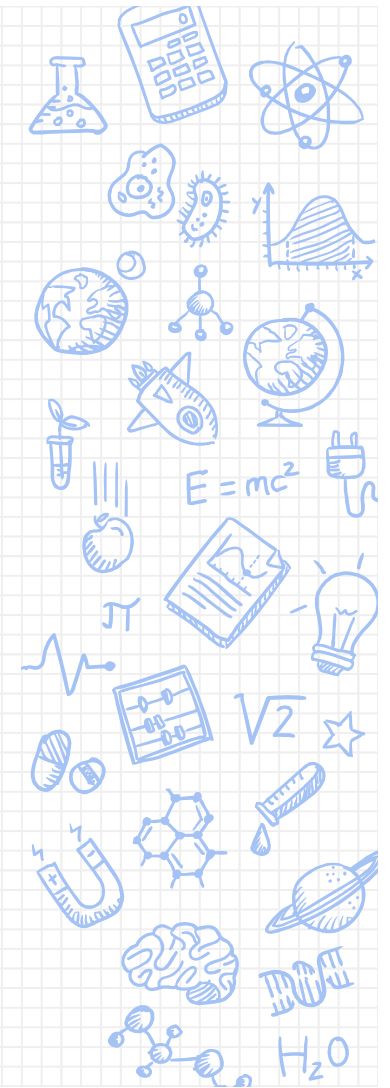
Materials and Equipment

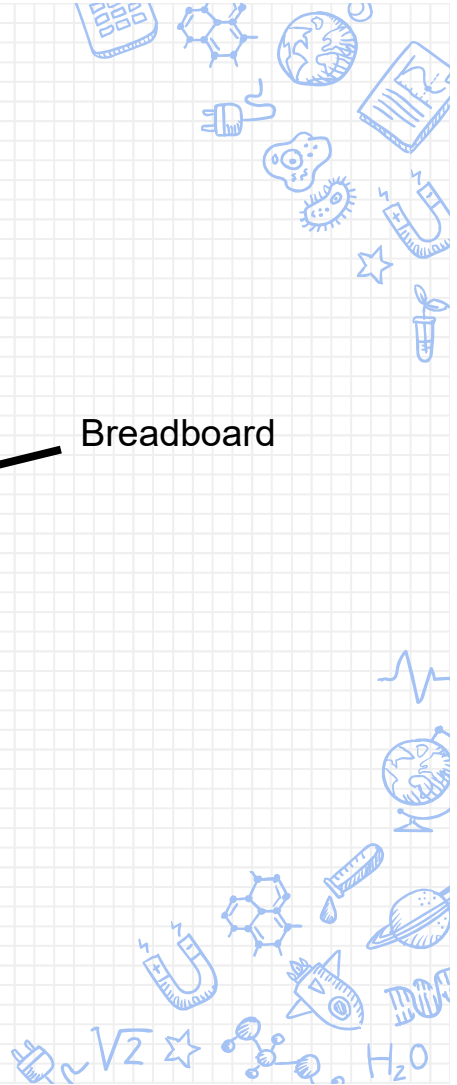
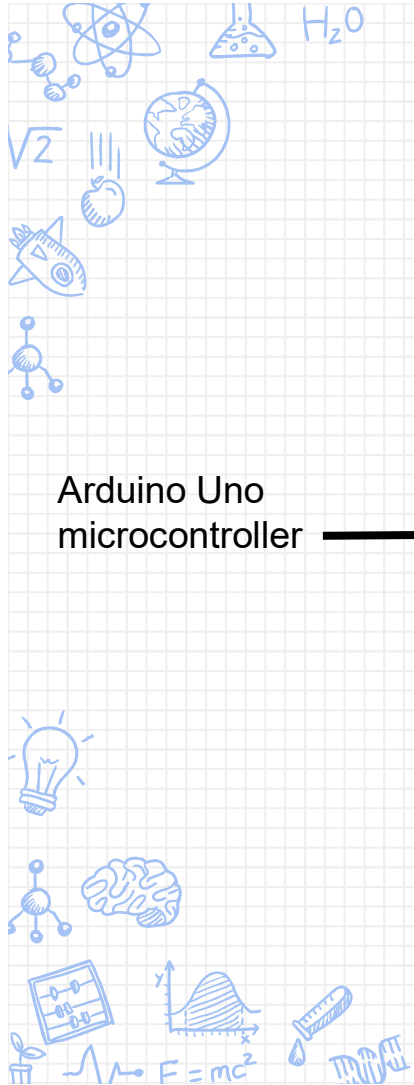
1. Computer with access to required downloaded software or web based applications.
2. Bread board
3. Micro-controller (Arduino, micro:bit)
4. Electrical components such as: jumper wires, resistors, LEDs, motors, sensors (temperature, light, humidity).

For beginners, suggest purchasing kits such as the following:

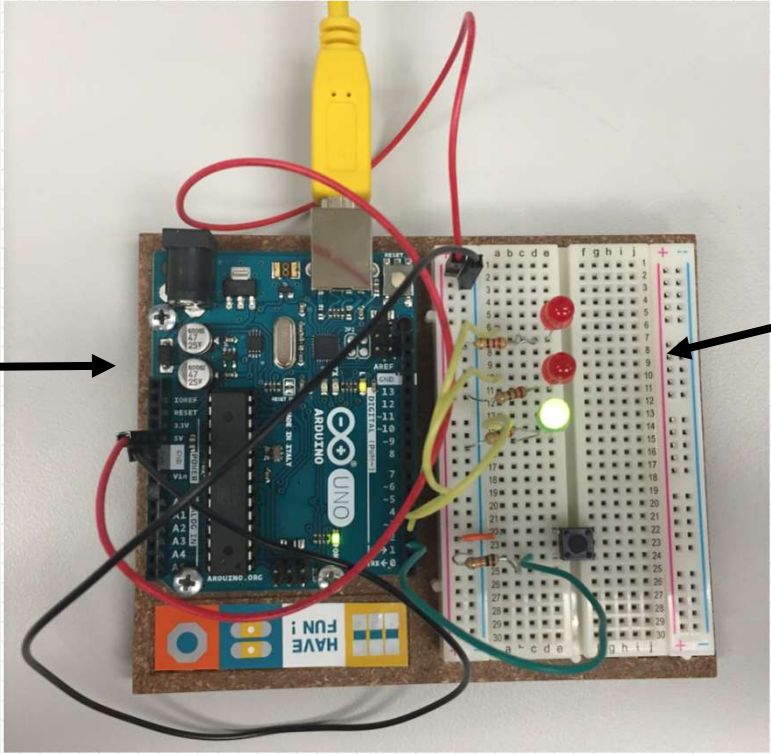
- ✗ [Arduino Starter Kit](#)
- ✗ [ElecFreaks Micro:bit Start Kit](#)

These kits come with all required components, building instructions, and coding instructions.





Arduino Uno
microcontroller

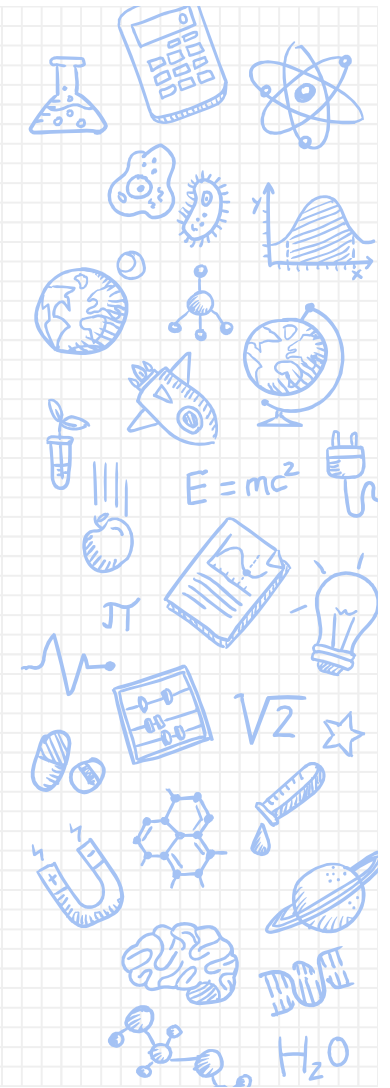


Breadboard



Suggested Equipment Management

- ✘ Ideal to have enough sets (breadboards, arduino board, micro:bits) for every 2 students. This ensures that all students are engaged in the learning.
- ✘ As sets will be used over a period of multiple periods, it is important to have enough for each class. It is not ideal to have classes sharing sets. Suggest that either enough sets be purchased for each class; or classes engage in activity at different times.

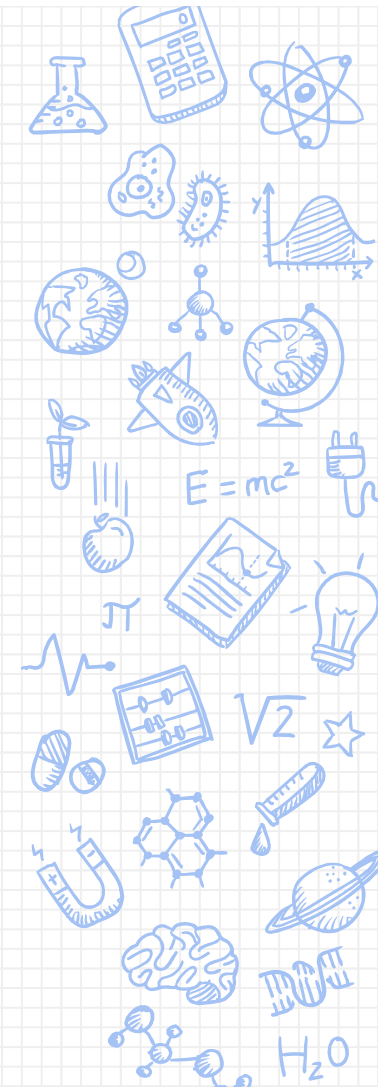


Suggested Equipment Management

- X Can use clear storage bins for student partners to store builds.
- X Every bin contains basic components (breadboard, micro-controller, USB cable) and students can add to it as needed. This way you don't lose any parts.



- X All other components can be kept in the following and students can get components when needed.



Lesson Progression

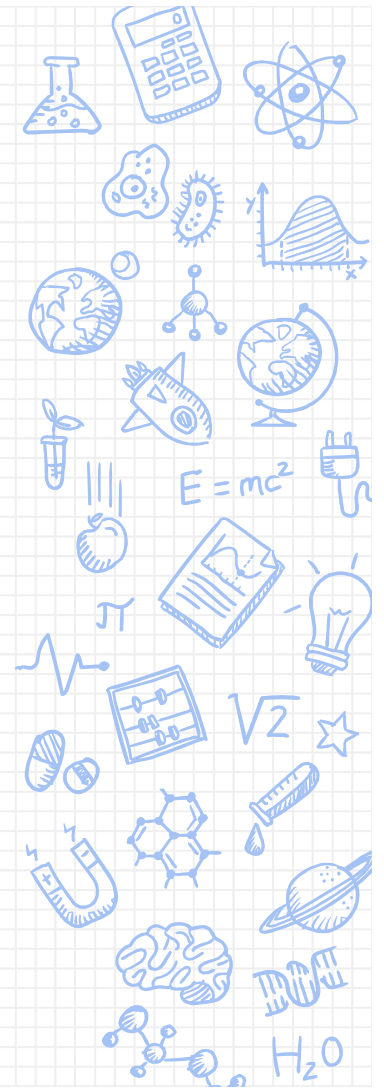
1. Breadboard

- X Describe what a breadboard is and how it works.
- X Use the breadboard to
 - i. teach components of a circuit
 - ii. build series and parallel circuits

2. Robotics and Coding (Arduino Uno/Micro:bit)

- X Using starter kits, build circuits and upload code
- X Adjust code and/or create code

1. Connections to Space Exploration



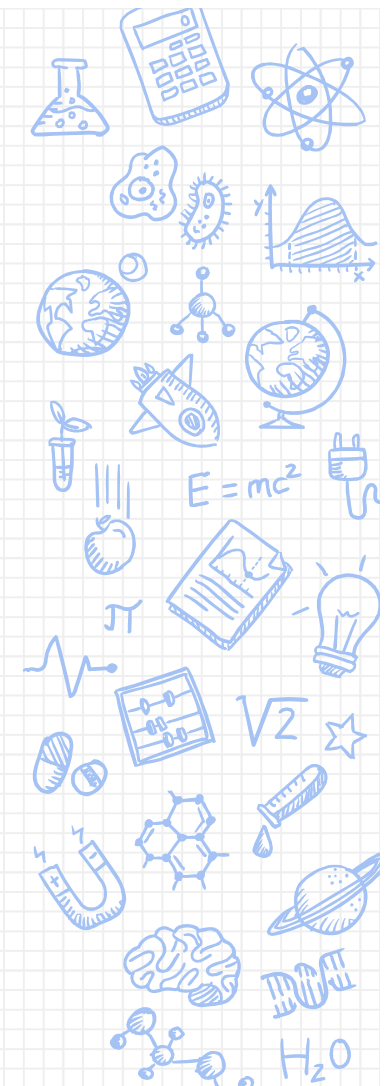
Breadboard Part 1

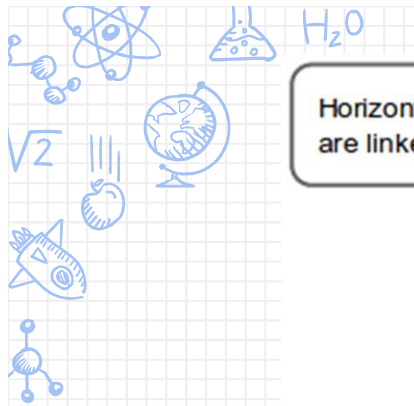
What is a breadboard and how does it work?

Breadboard – What is it and how does it work?

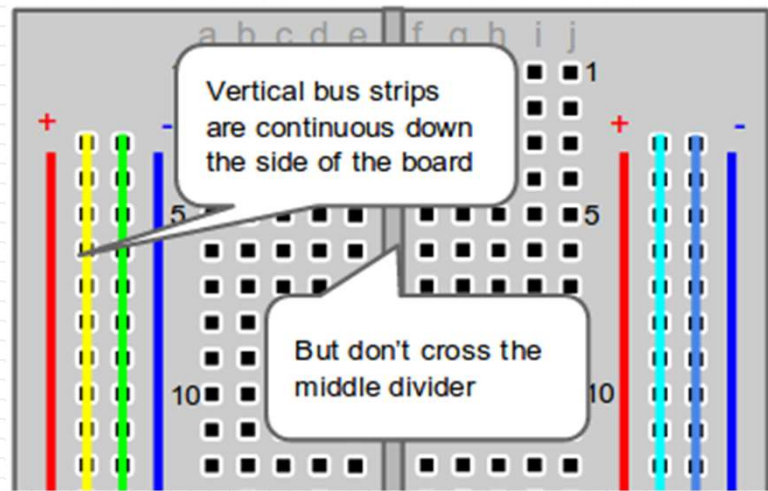
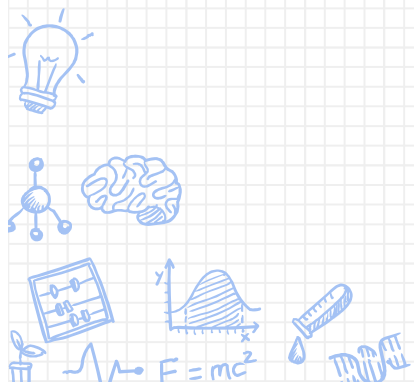
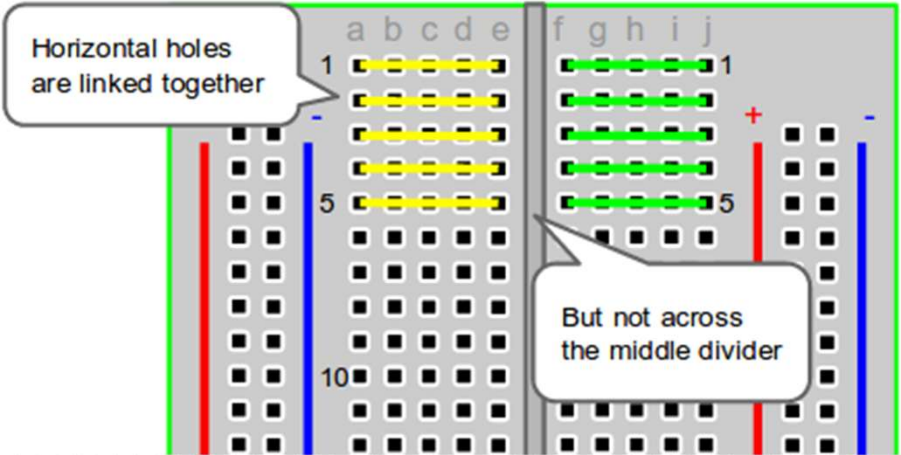
Important to practice building circuits with a breadboard first before adding on the coding/robotics component.

Start off with explaining what a breadboard is and show how they are set-up. You can show this to students by peeling off the back of the breadboard so that they can see where the metal components are.





H₂O



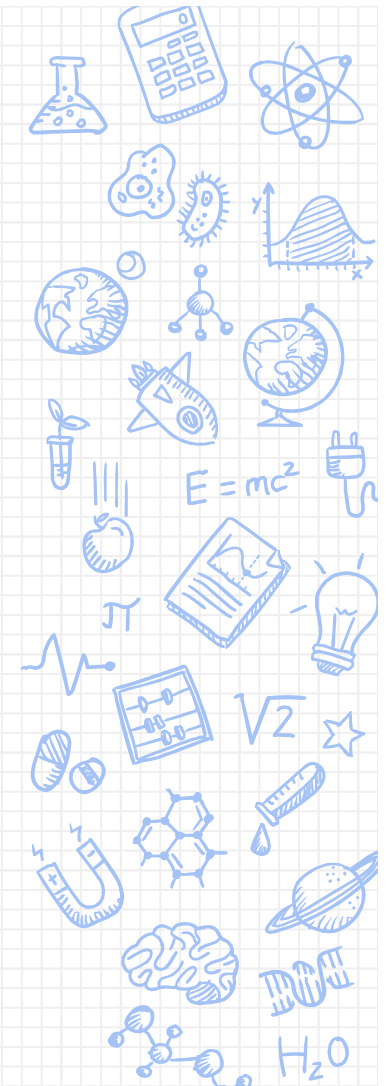
Resources: Breadboard – What is it and how does it work?

[Video - How to Use a Breadboard](#)

This video describes how to use a breadboard to build an electronic circuit, including the basics of how a breadboard works and some common mistakes that beginners tend to make.

A written version of this tutorial is available at

[Science Buddies - How to Use a Breadboard](#)

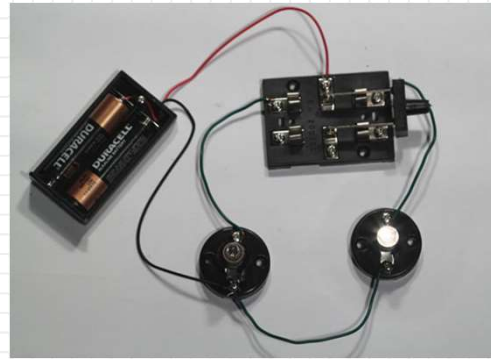
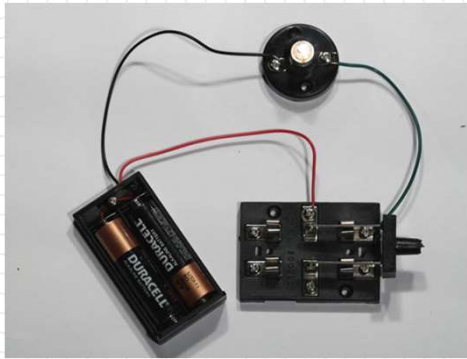


Breadboard Part 2

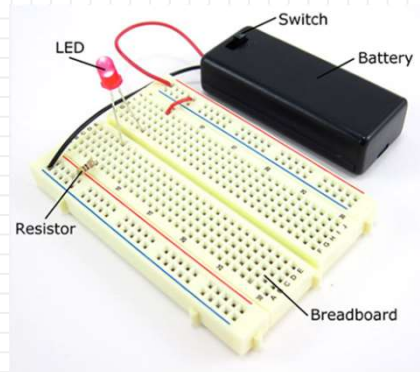
Using Breadboards to

- teach components of a circuit
- build series and parallel circuits

Instead of practice building circuits this way ...

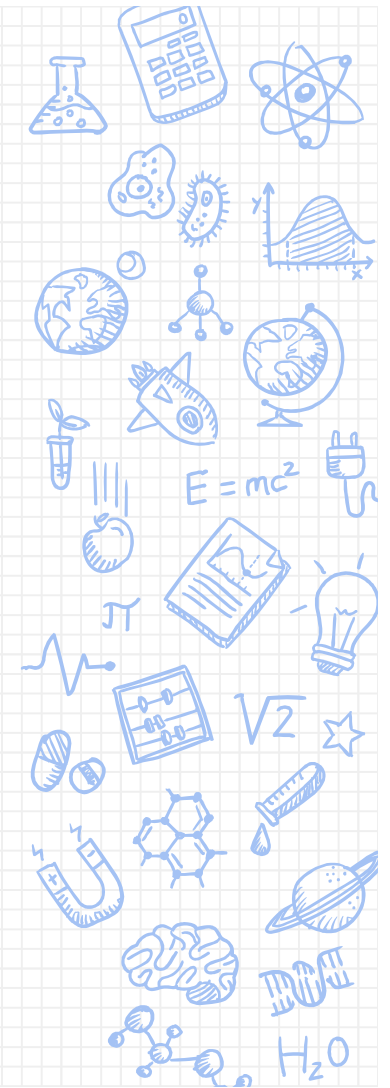


Have the students use breadboards to practice building circuits.



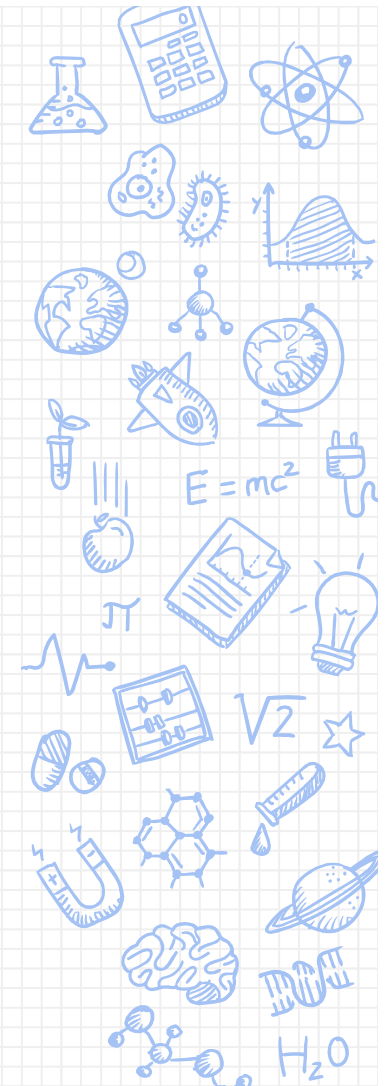
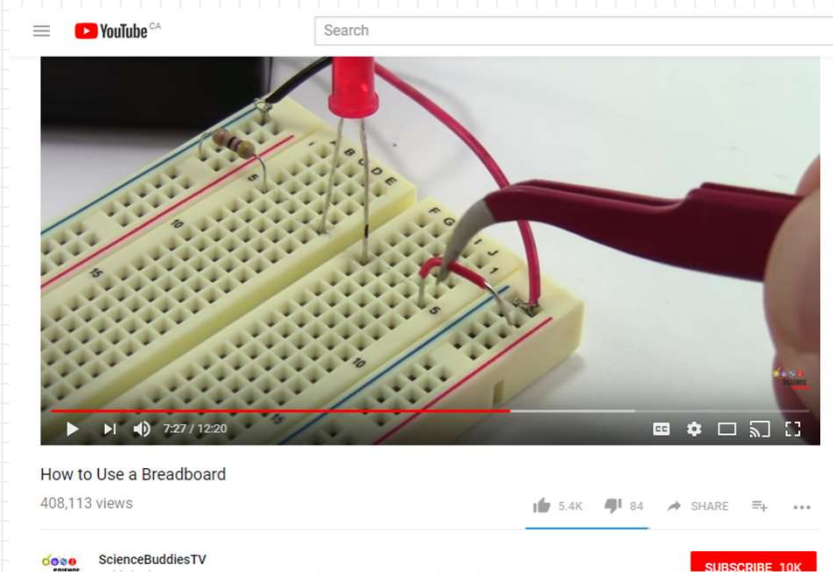
Tip – Use breadboard templates prior to building circuit with the actual breadboard and components

- ✘ Use templates to draw out where circuit components would be placed on the actual breadboard.
- ✘ Teacher can check student drawings first to make sure that the circuit is correct.
- ✘ Once the circuit drawing has been approved, students can obtain components and actually build it.

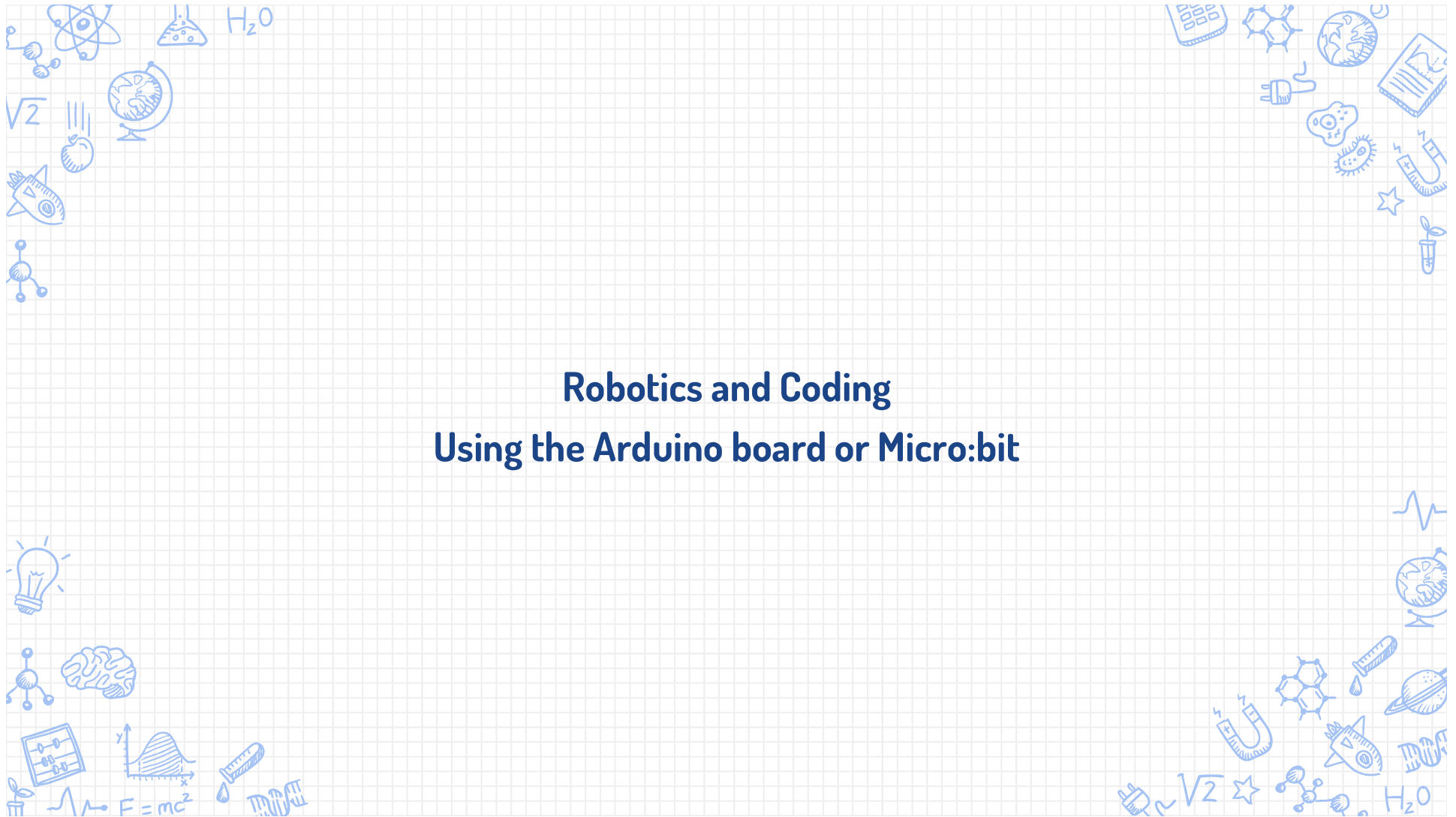


Tip for inserting components into the breadboard

For those student who struggle with inserting the components into the breadboard, try having them use tweezers to insert components.



Robotics and Coding
Using the Arduino board or Micro:bit

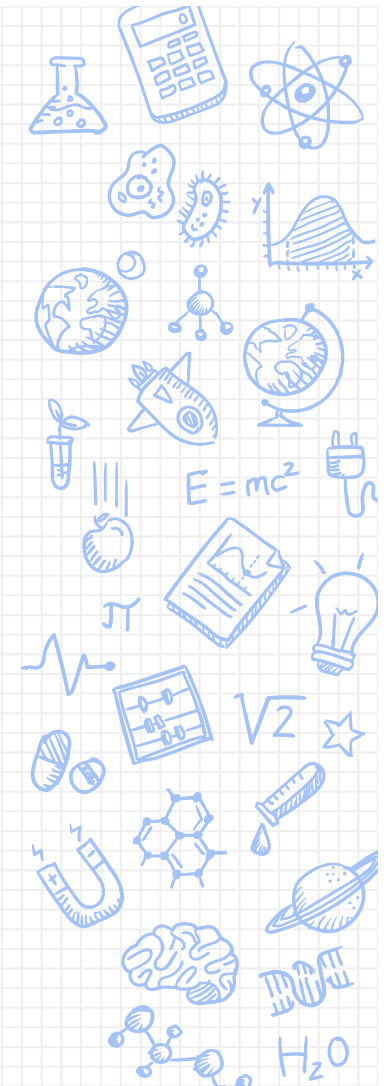


Connections to Science Curriculum – Possible Assessment Opportunities

As students build their circuits and input specific parameters into the code, they can:

1. demonstrate their understanding of components of a circuit, and describe each components functions
2. design and draw circuit diagrams of, and construct series and parallel circuits
3. compare, on the basis of observation, the differences between series and parallel circuits
4. explain why resistors are required in their circuit (such as with an LED)

Assessment is at the discretion of the teacher based on how you would normally assess these curriculum expectations.



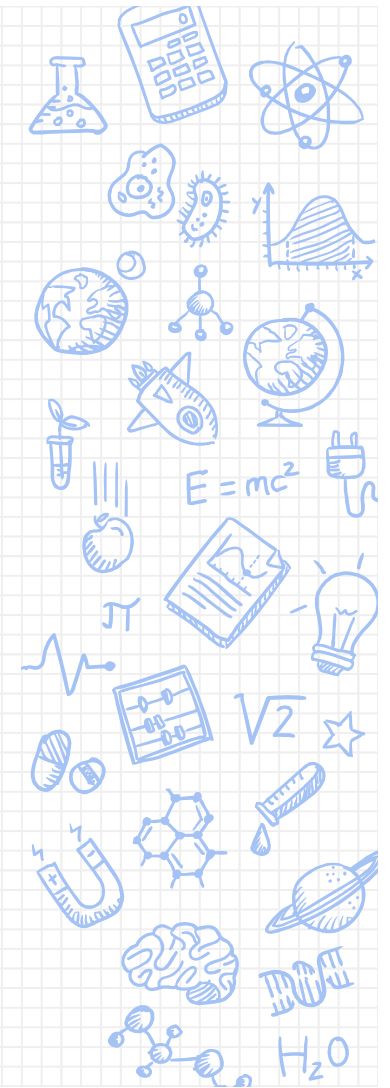
Starter Kits – Great place to start!!

The two starter kits that I have had experience with are the following:

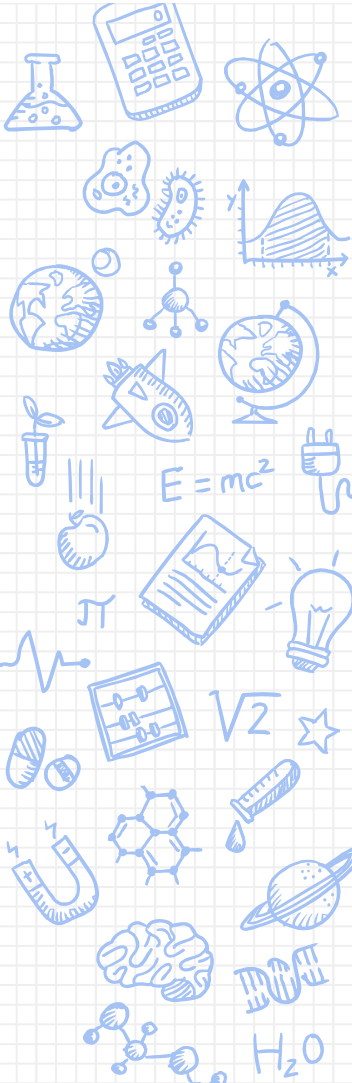
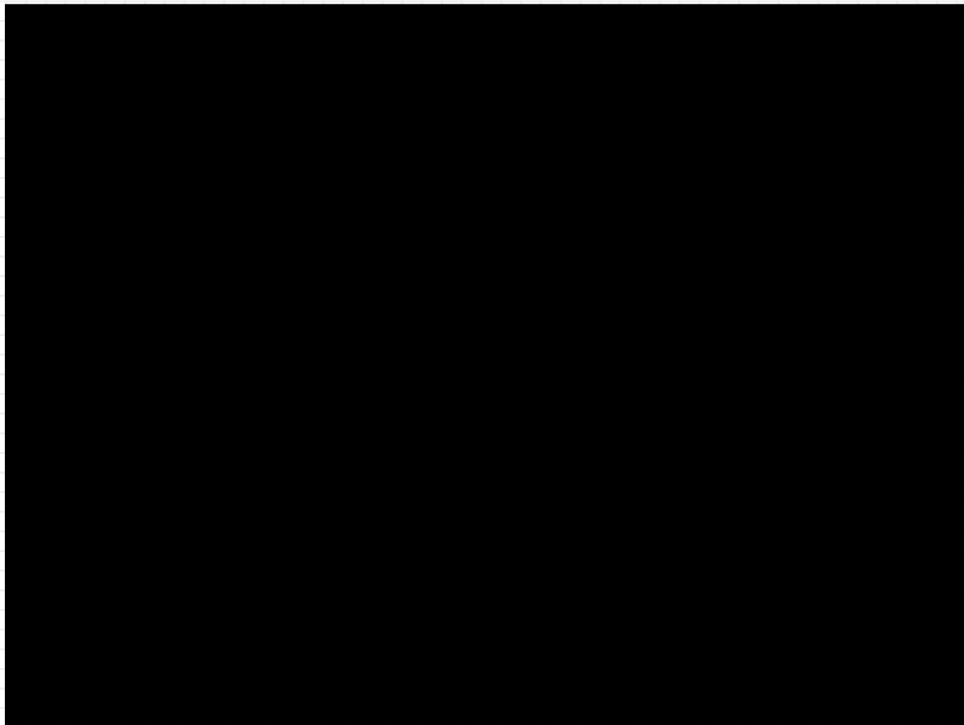
- ✗ [Arduino Starter Kit](#)
- ✗ [ElecFreaks Micro:bit Starter Kit](#)

These kits come with all required components, building instructions, and coding instructions.

By using these kits, you don't have to teach your students how to code. They learn the basic code that they need through already created project builds.

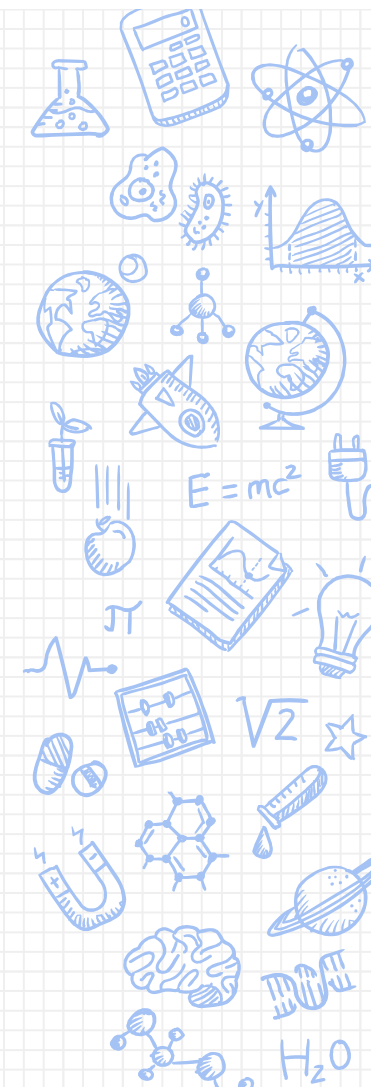


Sample project build



A few notes regarding the Starter Kits

| Arduino Starter Kit | ElecFreaks Micro:bit Starter Kit |
|---|--|
| Includes a project book with thorough step-by-step instructions. | Includes a project book, but with very basic instructions. |
| Approximate cost is \$100 | Approximate cost is \$50 |
| Kit includes breadboard, Arduino Uno, and 15+ components. | Kit includes breadboard, Micro:bit, and 10-15 components. |
| Coding software that is used with this kit is a free install, but will need to be installed on the computer. The coding for each project is preloaded into the program. | Coding software is web based and no installation is required. Coding can be done through a block based or javascript interface. Block based is much easier to use for those new to coding. |



Resources

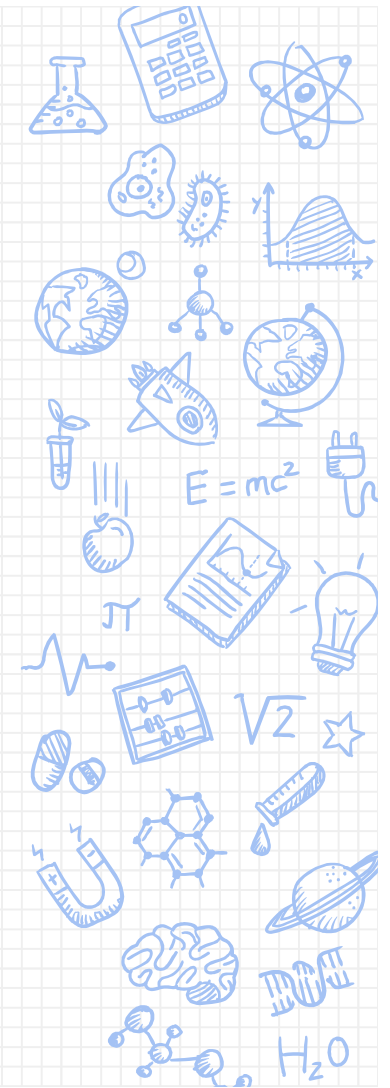
Arduino

- X [Download Arduino IDE](#) to Windows, MAC, and Linux systems.
- X [Online](#)

Tinkercad for circuits

- X Will need to sign-up for free account.
- X Educator can use to teach components, and building of circuit with breadboard.
- X Students can design circuit online, create code, and test out.

Micro:bit



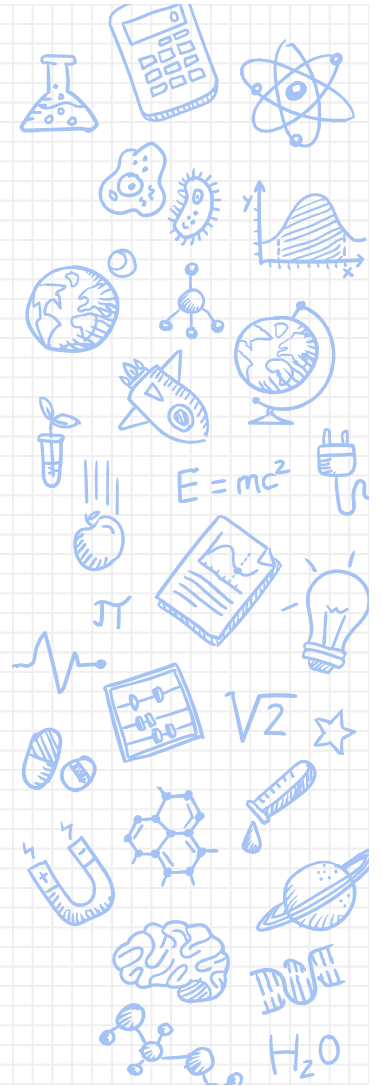
Arduino Starter Kit

The following is a sample list of projects students can make with this kit:

The screenshot shows the Arduino website interface. The navigation bar includes: HOME, BUY, SOFTWARE, PRODUCTS, EDU, RESOURCES, COMMUNITY, HELP. Below the navigation bar, there are two dropdown menus: GROVE and STORE INFO. A list of 15 project ideas is displayed, each preceded by a diamond bullet point. An arrow points from the text 'Temperature sensor' to the third item in the list.

- ◊ 01 GET TO KNOW YOUR TOOLS an introduction to the basics
- ◊ 02 SPACESHIP INTERFACE design the control panel for your starship
- ◊ 03 LOVE-O-METER measure how hot-blooded you are
- ◊ 04 COLOR MIXING LAMP produce any color with a lamp that uses light as an input
- ◊ 05 MOOD CUE clue people in to how you're doing
- ◊ 06 LIGHT THEREMIN create a musical instrument you play by waving your hands
- ◊ 07 KEYBOARD INSTRUMENT play music and make some noise with this keyboard
- ◊ 08 DIGITAL HOURGLASS a light-up hourglass that can stop you from working too much
- ◊ 09 MOTORIZED PINWHEEL a colored wheel that will make your head spin
- ◊ 10 ZOETROPE create a mechanical animation you can play forward or reverse
- ◊ 11 CRYSTAL BALL a mystical tour to answer all your tough questions
- ◊ 12 KNOCK LOCK tap out the secret code to open the door
- ◊ 13 TOUCHY-FEEL LAMP a lamp that responds to your touch
- ◊ 14 TWEAK THE ARDUINO LOGO control your personal computer from your Arduino
- ◊ 15 HACKING BUTTONS create a master control for all your devices!

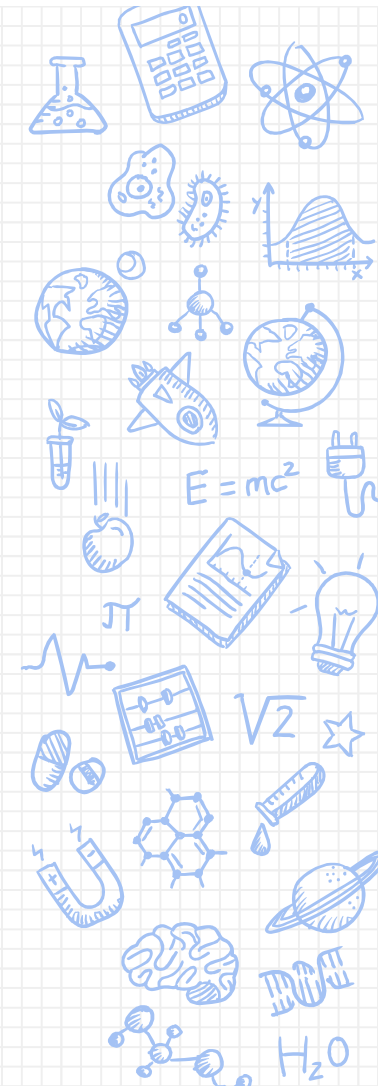
Temperature sensor



Arduino Starter Kit

The first project (Spaceship Interface) is available to view for free at <https://www.arduino.cc/en/ArduinoStarterKit/Prj02>

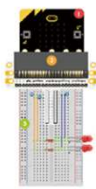
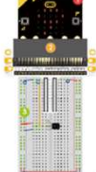
Video tutorials for each project from the starter kit can be found at https://www.youtube.com/playlist?list=PLT6rF_I5kknPf2qIVFlvH47qHvqvzkknd



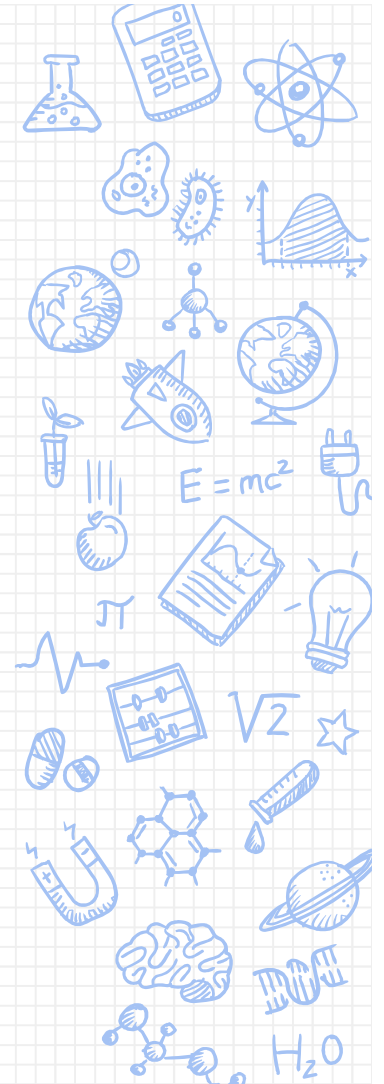
ElecFreaks Micro:bit Starter Kit

The following is a snapshot of the starter kit course samples:

Starter Kit Course Examples

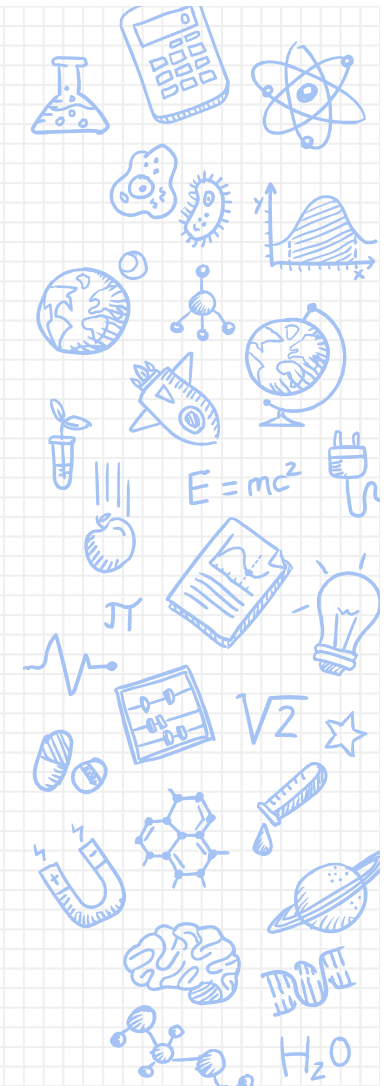
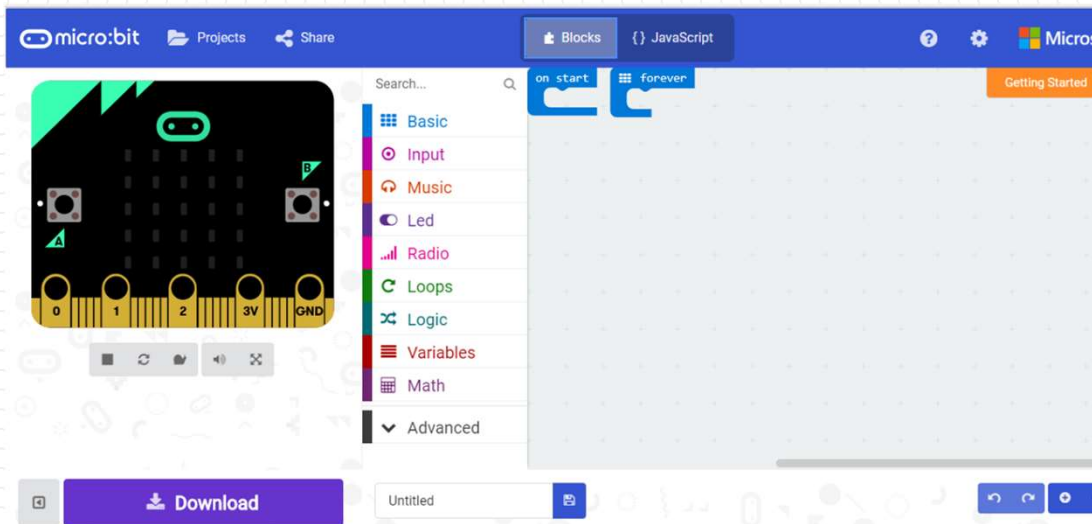
| | | |
|--|--|---|
| <p>1.LED</p> <p>Component List</p> <ul style="list-style-type: none">1 x Micro:bit Board1 x Micro:bit Breadboard Adapter1 x Breadboard2 x Red LED2 x 100Ω Resistor <p>Description</p> <p>In this course, we are going to use micro:bit to make 2 LED twinkle alternatively.</p> |  | <p>LED</p> <p>Make 2 LED twinkle alternatively.</p> |
| <p>7.Temperature Sensor</p> <p>Component List</p> <ul style="list-style-type: none">1 x Micro:bit Board1 x Micro:bit Breadboard Adapter1 x Breadboard1 x TMP36 Temperature Sensor <p>Description</p> <p>In this course, we are going to learn analog temperature sensor-TMP36 and display its data on the micro:bit.</p> |  | <p>Temperature Sensor</p> <p>Display its data on the micro:bit.</p> |

Explanations for each project can be found at https://www.elecFreaks.com/learn-en/Micro_bit_Starter_Kit/



ElecFreaks Micro:bit Starter Kit

The coding platform used for Micro:bits is [Microsoft MakeCode](#). It is web based, and has the advantage of having an option to use a block based interface. For anyone new to coding, this is much easier to use.



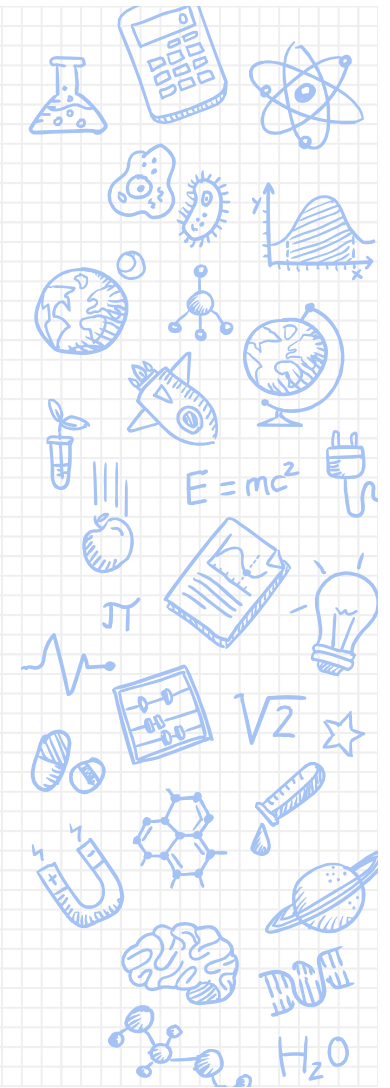
A decorative border of hand-drawn blue icons surrounds the central text. The icons include a calculator, a hexagonal molecule, a globe, a book, a plug, a cell, a microorganism, a star, a test tube, a lightbulb, a brain, a graph, a test tube, a DNA helix, a rocket, a star, a molecule, and the chemical formula H2O. In the top-left corner, there is a Bohr-style atom, a flask with a chemical reaction, the formula H2O, a square root symbol with a 2, a hand, a globe, a rocket, and a molecule. In the bottom-left corner, there is a lightbulb, a brain, a graph with axes labeled x and y, a test tube, and the equation E=mc^2.

Connection - Space Exploration Unit

At this point, students have:

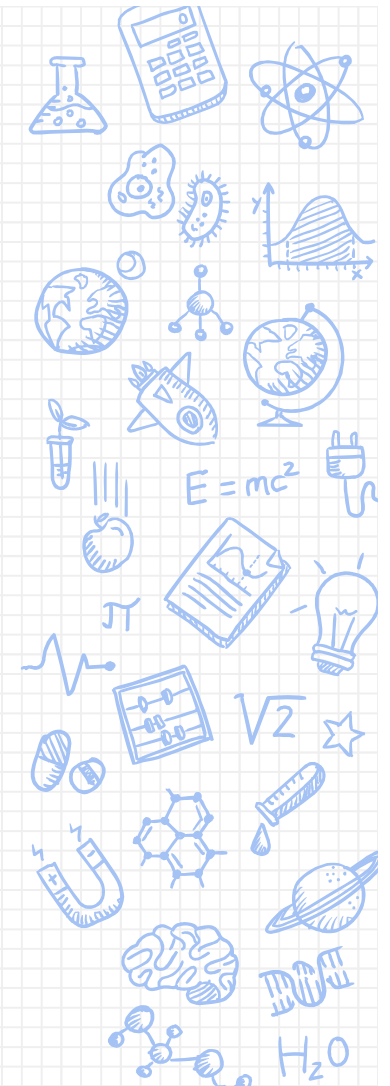
- X** built circuits - using a breadboard
- X** automated the inputs/outputs using code, and micro-controllers

This can be used as a launch into the Space unit through a discussion on the development of technologies for space exploration and the current space agency missions.



Sample Ideas

1. Build and code a device that will record the temperature inside a habitat. If the temperature reaches a specific value, have an LED light up or a sound produced to warn the inhabitants.
1. Build and code a device that will monitor the moisture in soil, and turn on a sprinkler system when water is needed to be added.
1. Build and code a device that provides information to a pilot trying to land on a planet surface. Could do this through the use of a light sensor, as you get closer to a surface, there would be less light registered.



Resources

Arduino. (2014, June 26). *Arduino Starter Kit - Video Tutorials by Massimo Banzi* [Video files]. Retrieved from https://www.youtube.com/playlist?list=PLT6rF_I5kknPf2qIVFlvH47qHvqvzkknd

Ben Miller. (2013, October 11). *How to Use a Breadboard and Build an LED Circuit*. [digital image] Retrieved from <https://computers.tutsplus.com/tutorials/how-to-use-a-breadboard-and-build-a-led-circuit--mac-54746>

Discount School Supply. *Clear storage bins* [digital image]. Retrieved from <https://www6.discountschoolsupply.com/Product/ProductDetail.aspx?Product=36334>

Doug Lowe. *Electronic Projects: How to Build a Switched Lamp Circuit*. [digital image - series circuit]. Retrieved from <https://www.dummies.com/programing/electronics/diy-projects/electronics-projects-how-to-build-a-switched-lamp-circuit/>



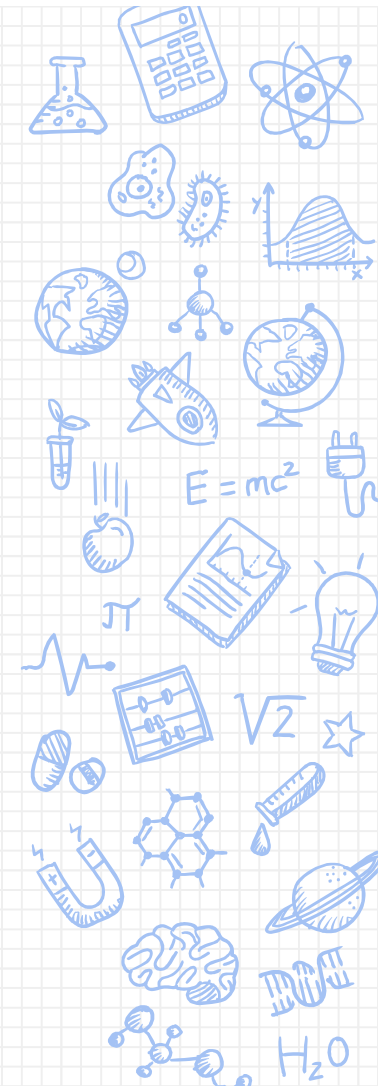
Resources

Doug Lowe. *Electronic Projects: How to Switch Between Two Lamps*. [digital image - parallel circuit]. Retrieved from <https://www.dummies.com/programming/electronics/diy-projects/electronics-projects-how-to-switch-between-two-lamps/>

Ontario Ministry of Education. *The Ontario Curriculum, Grades 9 and 10: Science, 2008 (revised)*. Retrieved from <http://www.edu.gov.on.ca/eng/curriculum/secondary/science.html>

Ontario Ministry of Education. *The Ontario Curriculum Grades 1-8: Science and Technology, 2007*. Retrieved from <http://www.edu.gov.on.ca/eng/curriculum/elementary/scientec18currb.pdf>

Ready 2 Fish. *Fishing tackle box* [digital image]. Retrieved from <https://www.amazon.ca/Ready-Fish-Saltwater-Tackle-Basic/dp/B007PXRNC8>



Resources

Science Buddies. *How to Use a Breadboard*. [digital image]. Retrieved from <https://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-breadboard>

ScienceBuddies TV. (2015, September 17). *How to Use a Breadboard* [Video file]. Retrieved from https://www.youtube.com/watch?time_continue=15&v=6WReFkfrUIk.

