Robogals Science Challenge

Minor Challenge Set #3
STEM Field: Electrical Engineering
Level: Intermediate
Challenge Name: Blinking Multiple LEDs with Arduino and Breadboard
Project Cost: 0 USD
Materials Required:
- Laptop/ Computer with Internet access
- An account on TinkerCAD (a free software)
    - Registration for an account is necessary to save progress

Duration:
- The challenge takes approximately one to two hours to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules

Introduction:

Arduino is a platform used to create interactive electronic projects. We can use Arduino boards to read an input, for example, light on a sensor, and turn it into an output, such as turning on an LED. If you want to tinker with a project that involves both software (coding) and hardware (building electrical circuits), Arduino is a great way to start.

To work on an Arduino project, you will need an Arduino board, wires, batteries, resistors, LEDs and more components, depending on the project you are working on. It may be difficult to gather all the required

components, therefore, in this activity, we will use TinkerCAD - a free software with tools to build electronic circuits and simulate them.

In this project, we will build an electronic circuit with multiple LEDs using Arduino and breadboard. Upon completion of this activity, you may like to build more difficult circuits and submit them as a Major Challenge. You may also like to check out the Senior project for more electronic projects using Arduino!

Instructions:

Part 1: Setting Up

1. Navigate to the website: https://www.tinkercad.com. It is recommended that you open this website on a browser such as Chrome. This software is free-to-use, and creating an account is necessary to save the progress of your project.

   If you have not registered, click "JOIN NOW", then select "Create a personal account".

   Alternatively, click "Sign In" to log into your TinkerCAD account.

2. After you have logged in, you will see a dashboard with projects you are working on. TinkerCAD can be used to create 3D models or other software projects. In this activity, we will build our electronic circuit, so select "Circuits", then "Create new Circuit" (See the figure below).
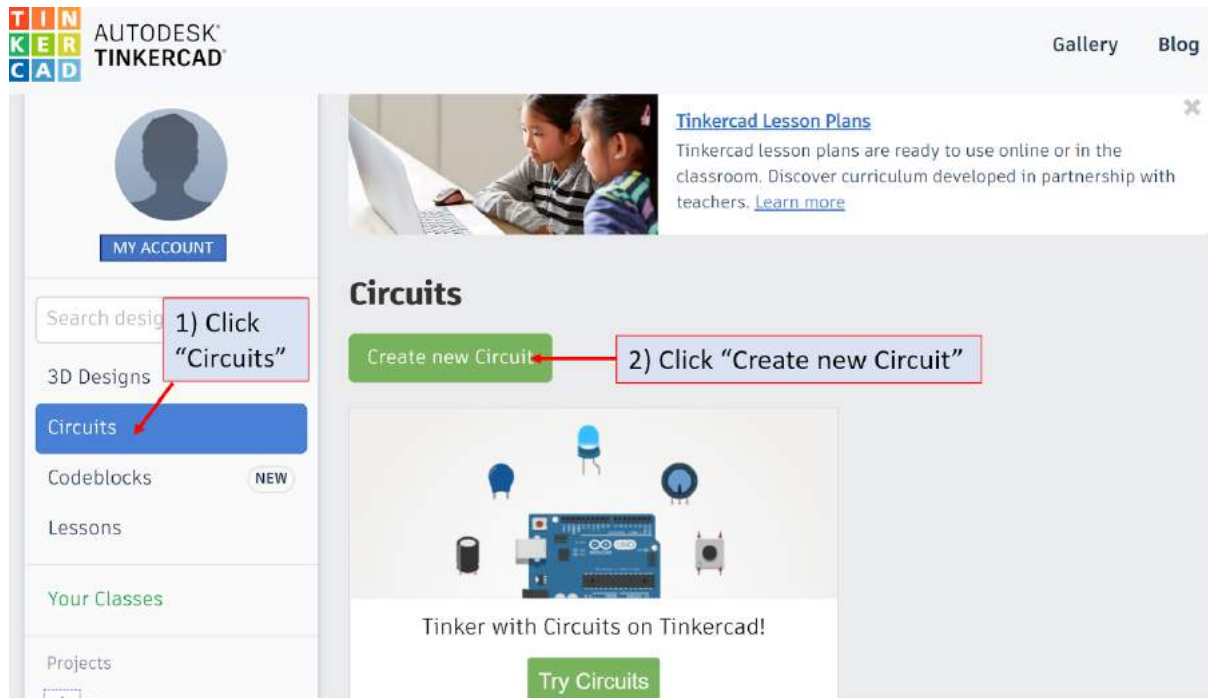
3. This is what your project dashboard will look like. The figure below shows the main functions you should be aware of before building your project.
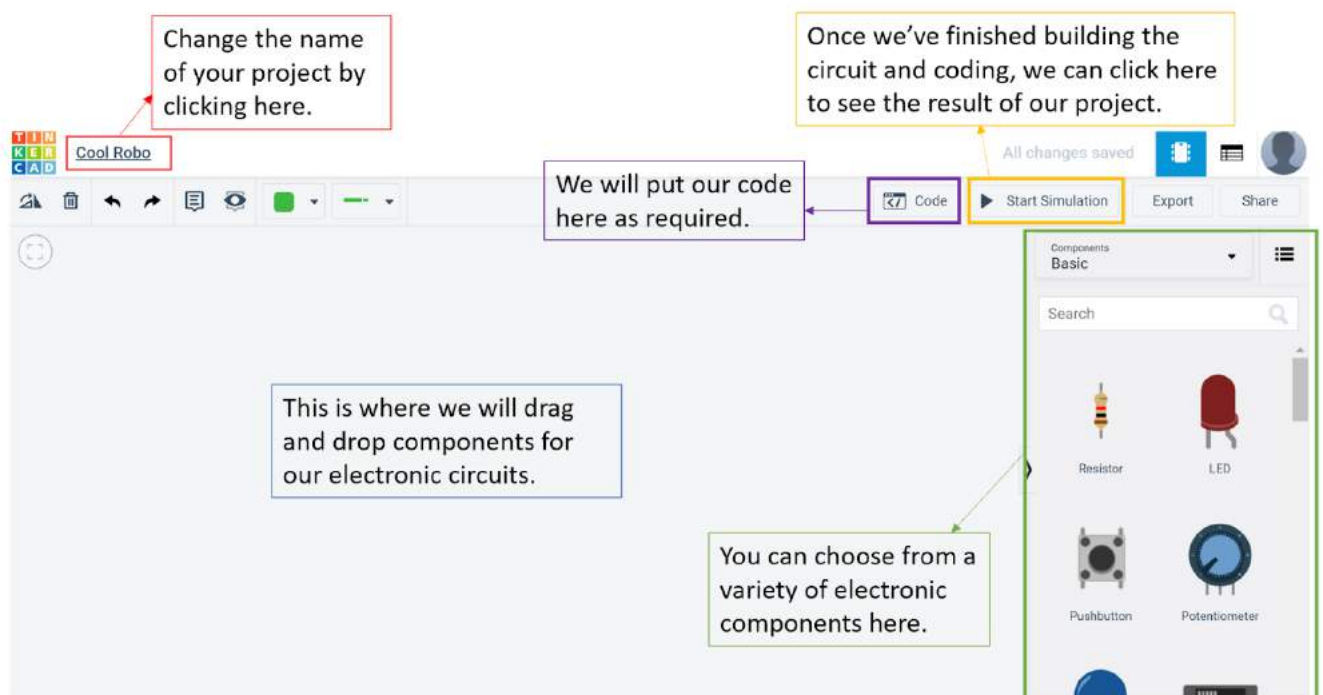
4. In this project, you will need 1x Arduino Uno board, 1x small breadboard, 3x LEDs and 3x resistors. Drag and drop the components to the space provided.

5. Click on each resistor and change the resistance to 220 Ω. The symbol "Ω" is read as "ohms", which is a unit used to measure the resistance of an electrical device. Resistance is a property that reduces the current flow in a circuit.

    Explanation: We need to use a resistor for our LED circuit. If there is too much current flowing through the LED, it may burn the LED out. A resistor is a component used to limit the current flow, and so helps prevent the LED from burning.
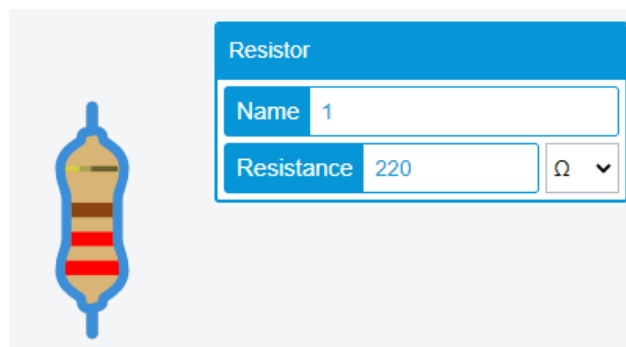

6. Click on each LED and change to different colours of your choice.
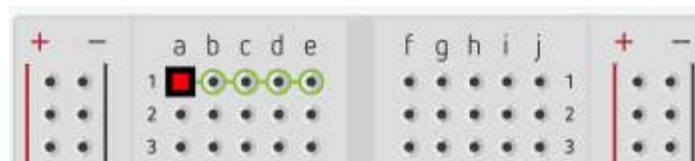
Part 2: Using the Breadboard

A breadboard is a useful tool to use when you want to build circuits with multiple electronic components.

On the left and right hand side of the breadboard are power rails (highlighted in the blue box). When you connect a power source (for example, a battery, an Arduino) to these power rails, they provide power to other electronic components as you connect them to the breadboard.
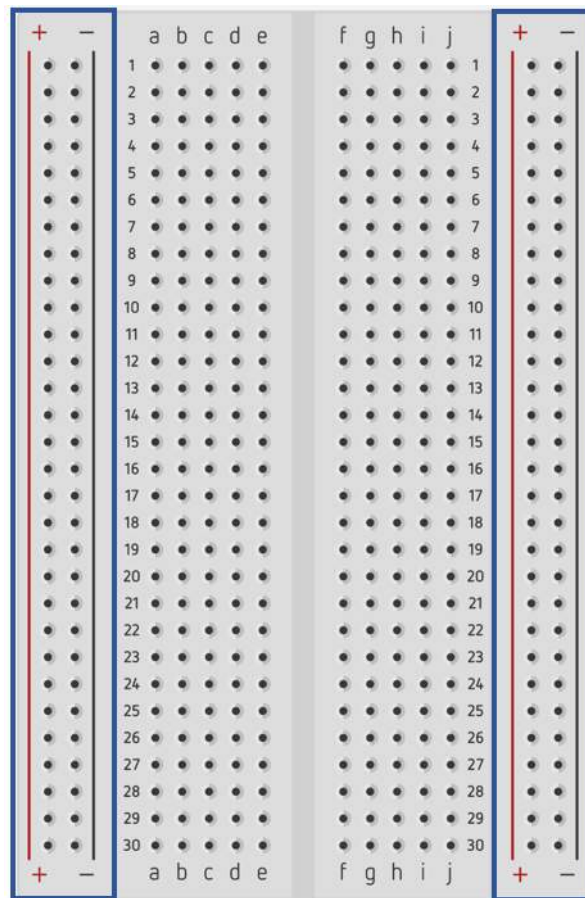
Hover your mouse over a row in the middle of the breadboard, you will see the entire row is highlighted in green. This means that they are electrically connected to one another.


As both sides of the breadboard are not electrically connected, it is best practice to connect the **+** and **-** rails on both sides together using wires.

7. To add wires, click on two ends of the components you want to connect. Add wires to the breadboard as shown below. Click on each wire and change the colour to match the figure.
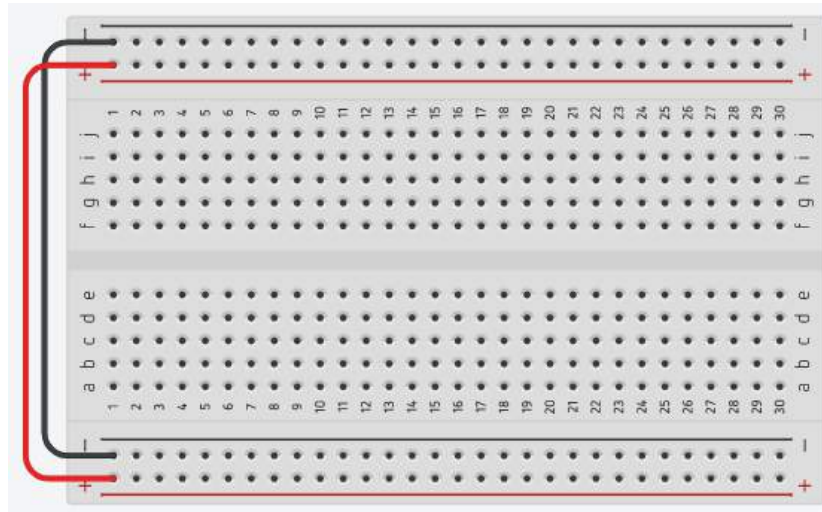
Part 3: Connect the Power Source

8. Add wire to connect the "5V" pin on the Arduino to one of the (**+**) power rails on the breadboard. Change the colour of the wire to red.

9. Similarly, add a black wire to connect the "GND" (Ground) pin on the Arduino to one of the (**-**) power rails on the breadboard.
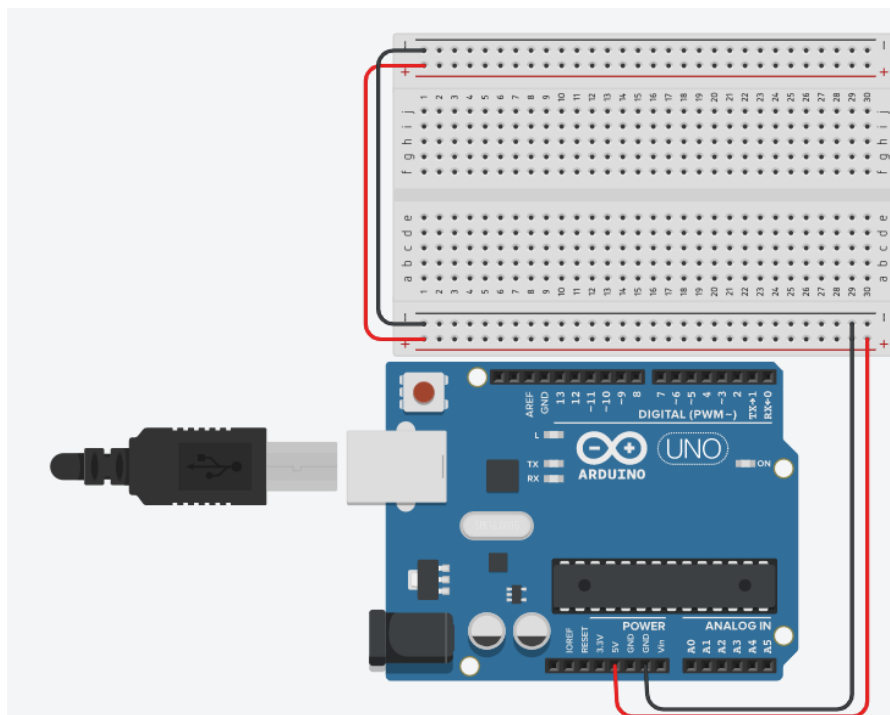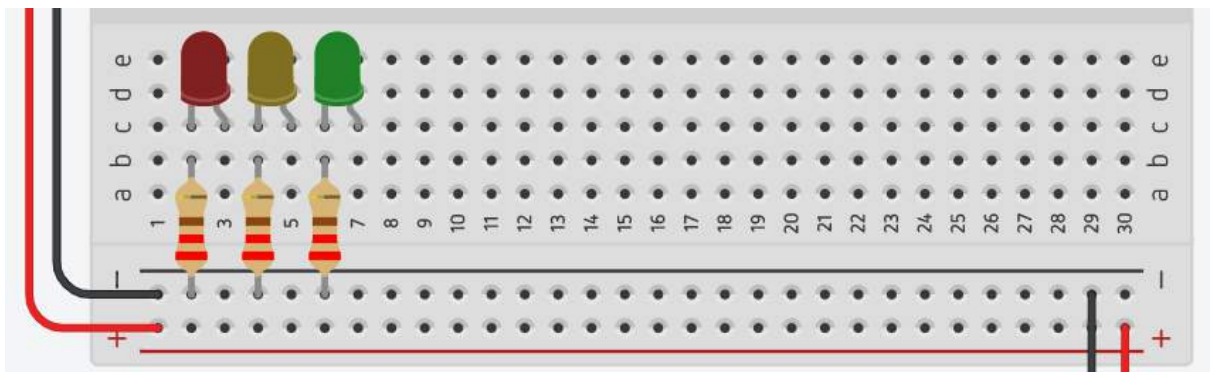
Part 4: Build the Circuit

10. Connect each LED to the breadboard. Position the LEDs so that each leg is connected to a different numbered column on the breadboard.
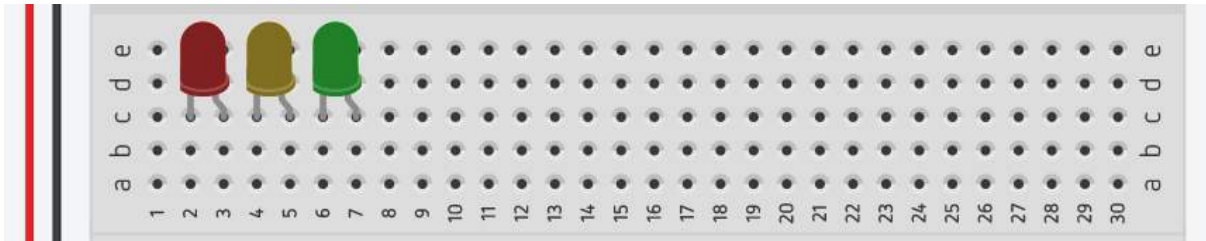

11. Add the resistors to the breadboard. Each resistor must be positioned on the same column as the negative leg (shorter, straight leg) of the LED. The other side of the resistor is connected to the (-) power rail.

12. Add wires to connect each LED to a different digital pin on the Arduino. Here, we are connecting the red LED to pin 13, yellow LED to pin 12, and green LED to pin 11. Change the colour of the wires to match the colour of the LED.

    Here, we are connecting the positive (straighter, bent) leg of the LED to the output pin on the Arduino.
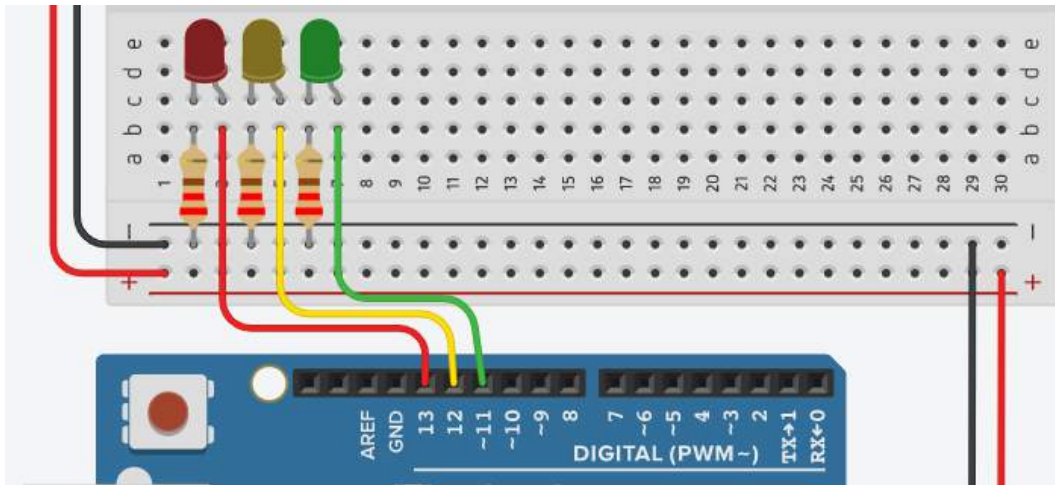
Part 5: Adding Code

13.   We will now add code to our electrical circuit by clicking on the

              `</> Code` symbol.

14.   We want to turn on the red LED (connected to pin 13) by setting it to HIGH for one second. Then, we want to turn off the LED by setting it to LOW for one second. You can replicate the below code to achieve this.

The blue code blocks can be found in the "Output" section, and the yellow code blocks in the "Control" section.
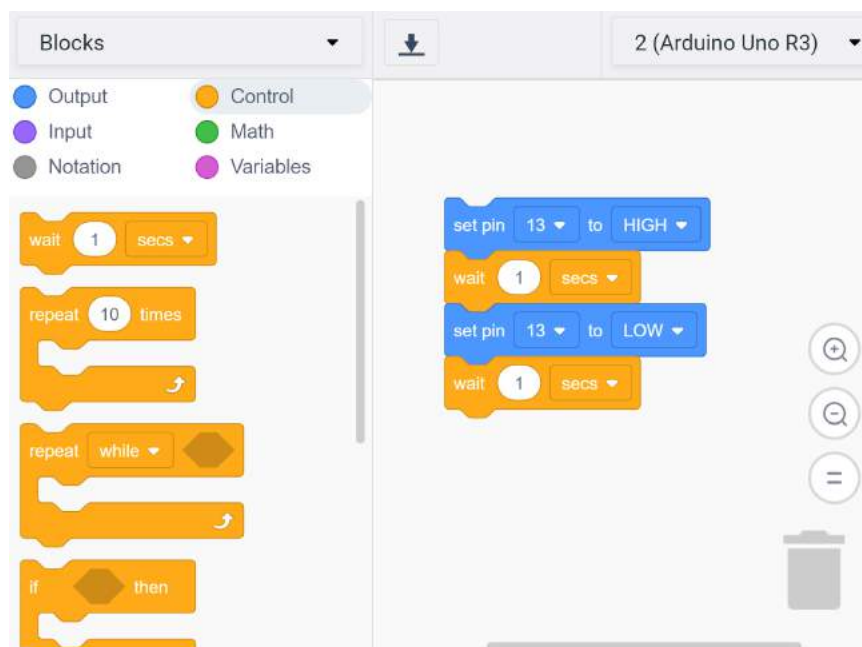
15.   We then repeat this process for the yellow and green LEDs.

16.   You can now click on "Start Simulation" and see how your
      circuit behaves.

Extension - Make your own blinking LED circuit

Apply what you have learned and build your own blinking LED circuit.
You can add as many LEDs as you like, modify the colour of these
LEDs. You can also modify the code to have different blinking patterns.

Tip:

Use the "Repeat" code block if you want to repeat a blinking pattern,
instead of repeating the codes. Change the number of times you want
to repeat the pattern.
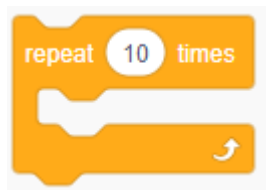
Reflection Questions:

- Are there any improvements you would make to this challenge?
- What real world application/s can you apply this challenge to?
- What are the key science and engineering concepts that relate to this challenge?

- What other circuits would you like to build and why?
- A common mistake we make when working with breadboards is connecting an electronic component to the wrong row or column on the breadboard. For example, in the below scenario, the red LED will not blink as intended. Can you explain why?
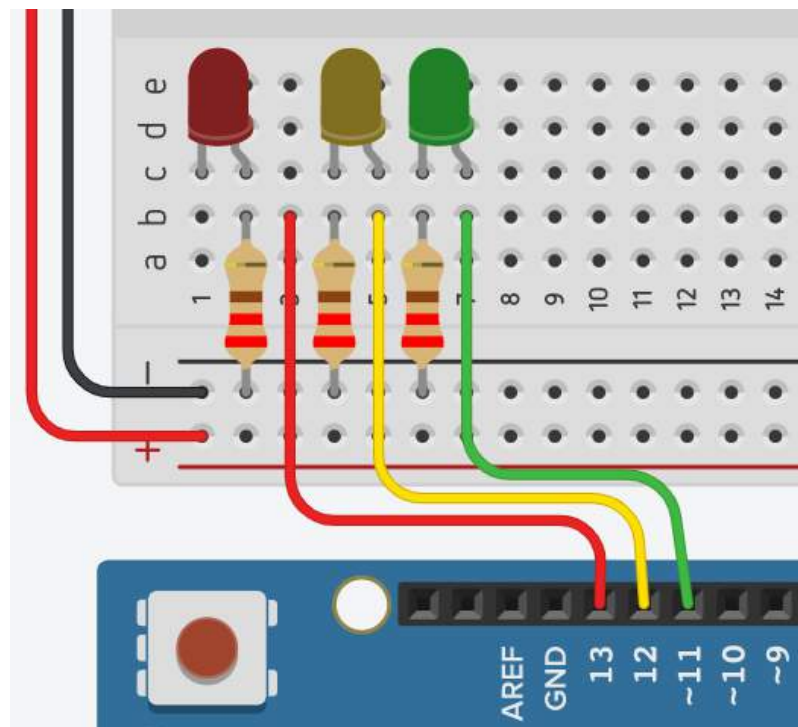
- Assuming we are connecting the LEDs to the correct rails on the breadboard. Now, we remove any resistor from the circuit. For example, in the scenario below, the red LED will not work as intended. Can you explain why?
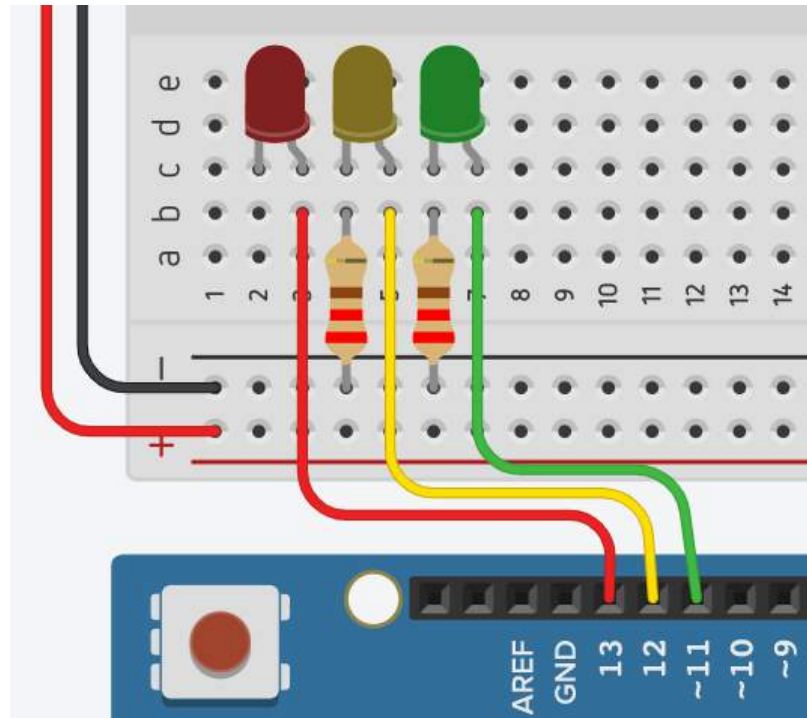
Submission Guidelines:

- Submit a photo of the code and your circuit, including any code or circuits you built as part of the Extension task. Include a short summary that addresses the reflection questions.

  Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your parent or guardian first.

- The submission form is on the Minor Challenges page: https://sciencechallenge.org.au/index.php/minor-challenges/ Fill out the details and make sure you upload your submission.

Learn More! Resources:

- This website has lots of projects and lessons for beginners: https://www.tinkercad.com/learn/circuits/learning

- If you want to see what other people are building or tinkering with, have a look at the Gallery section of TinkerCAD: https://www.tinkercad.com/things
- If you want to learn more about conventional current flow, have a look here: https://web.engr.oregonstate.edu/~traylor/ece112/beamer_lectures/elect_flow_vs_conv_I.pdf