

Minor Challenge Set #3

STEM Field: Electrical Engineering

Level: Senior

Challenge Name: Build a Temperature Sensor Circuit with Arduino

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 using Arduino, breadboard and TMP36 temperature sensor. We want our circuit to detect the temperature using the sensor, then light up the LEDs accordingly. The higher the temperature detected, the more LEDs will be lit up.

Upon completion of this activity, you may like to build more difficult circuits and submit them as a Major Challenge.

Instructions:

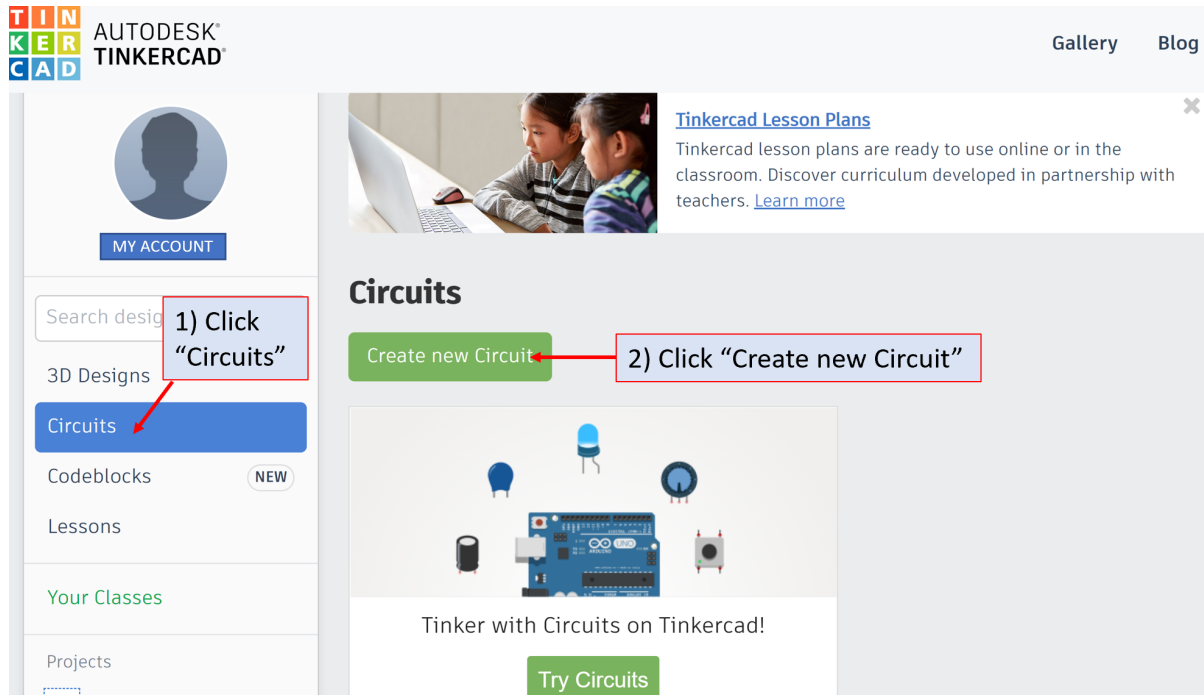
Part 1: Setting Up

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.

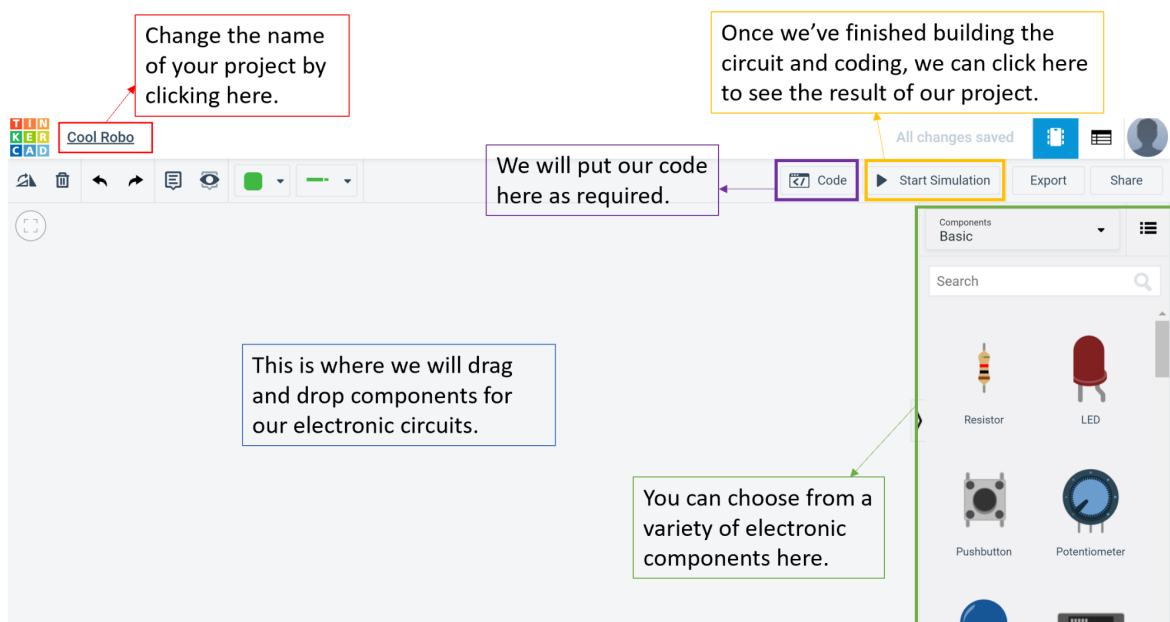
If you have not registered, click “JOIN NOW”, then select “Create a personal account”.

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

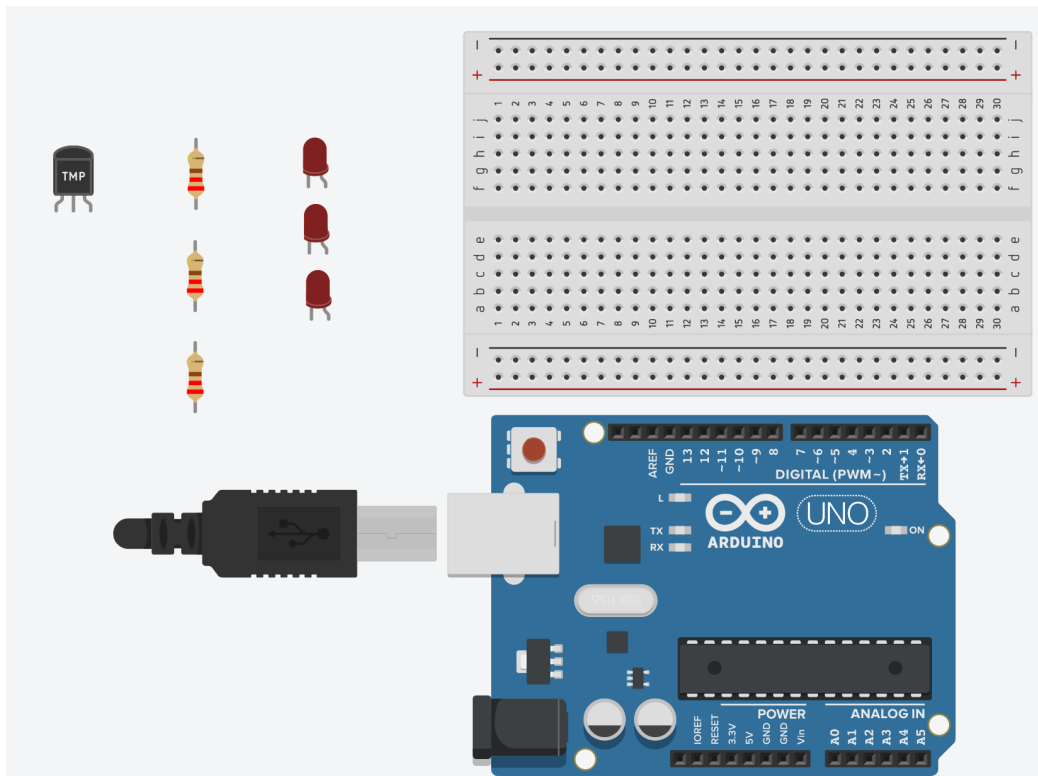
2. After you have logged in, you will see a dashboard with projects you are working on. TinkerCAD can be used to create 3D models or other software projects. In this activity, we will build our electronic circuit, so select “Circuits”, then “Create new Circuit” (See the figure below).



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.

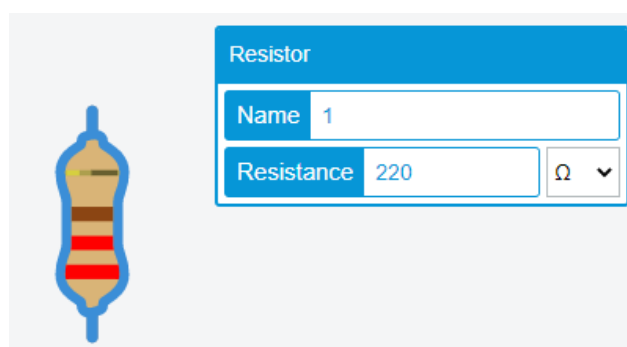


4. In this project, you will need 1x Arduino Uno board, 1x small breadboard, 3x LEDs and 3x resistors. Drag and drop the components to the space provided.



- Click on each resistor and change the resistance to 220 ohms (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.

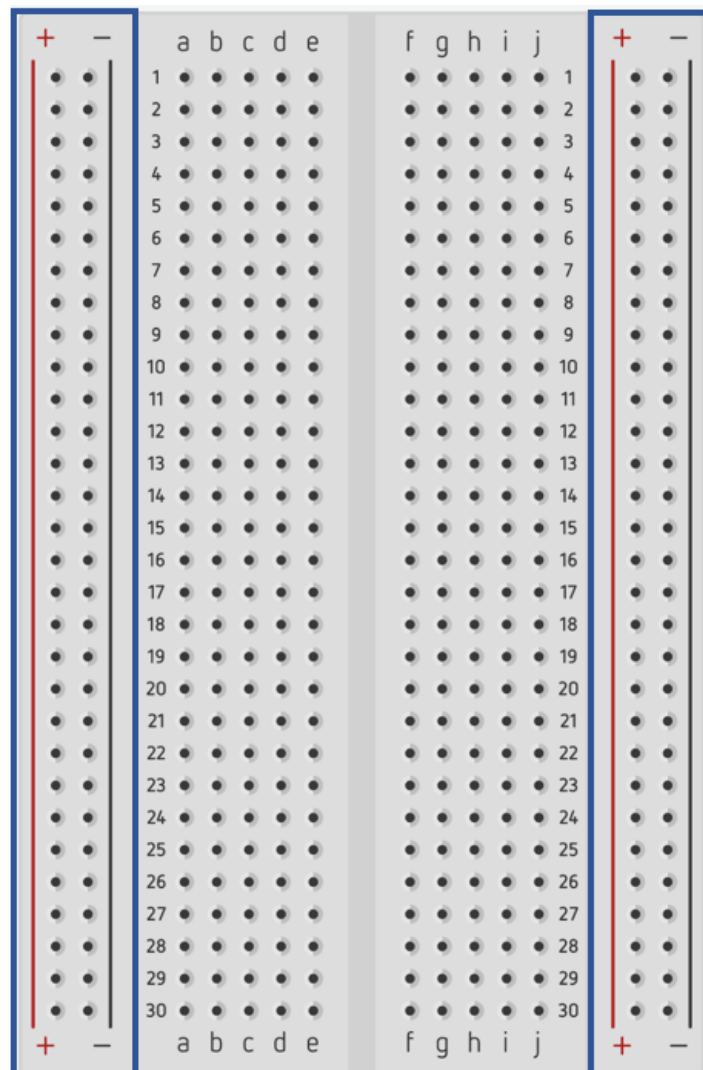
Explanation: We need to use a resistor for our LED circuit. If there is too much current flowing through the LED, it may burn the LED out. A resistor is a component used to limit the current flow, and so helps prevent the LED from burning.



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.

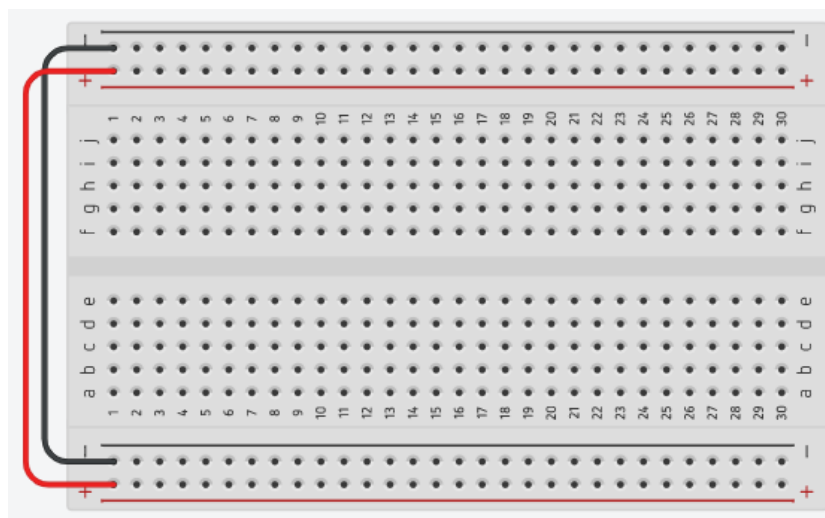


Hover your mouse over a row in the middle of the breadboard, you will see the entire row is highlighted in green. This means that they are electrically connected to one another.



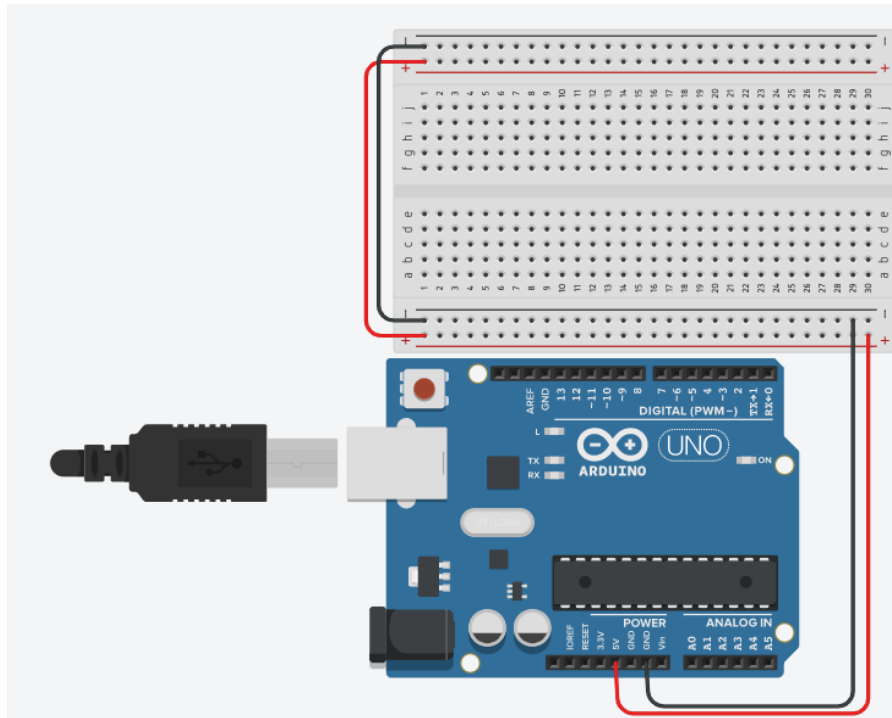
As both sides of the breadboard are not electrically connected, it is best practice to connect the + and - rails on both sides together using wires.

6. 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

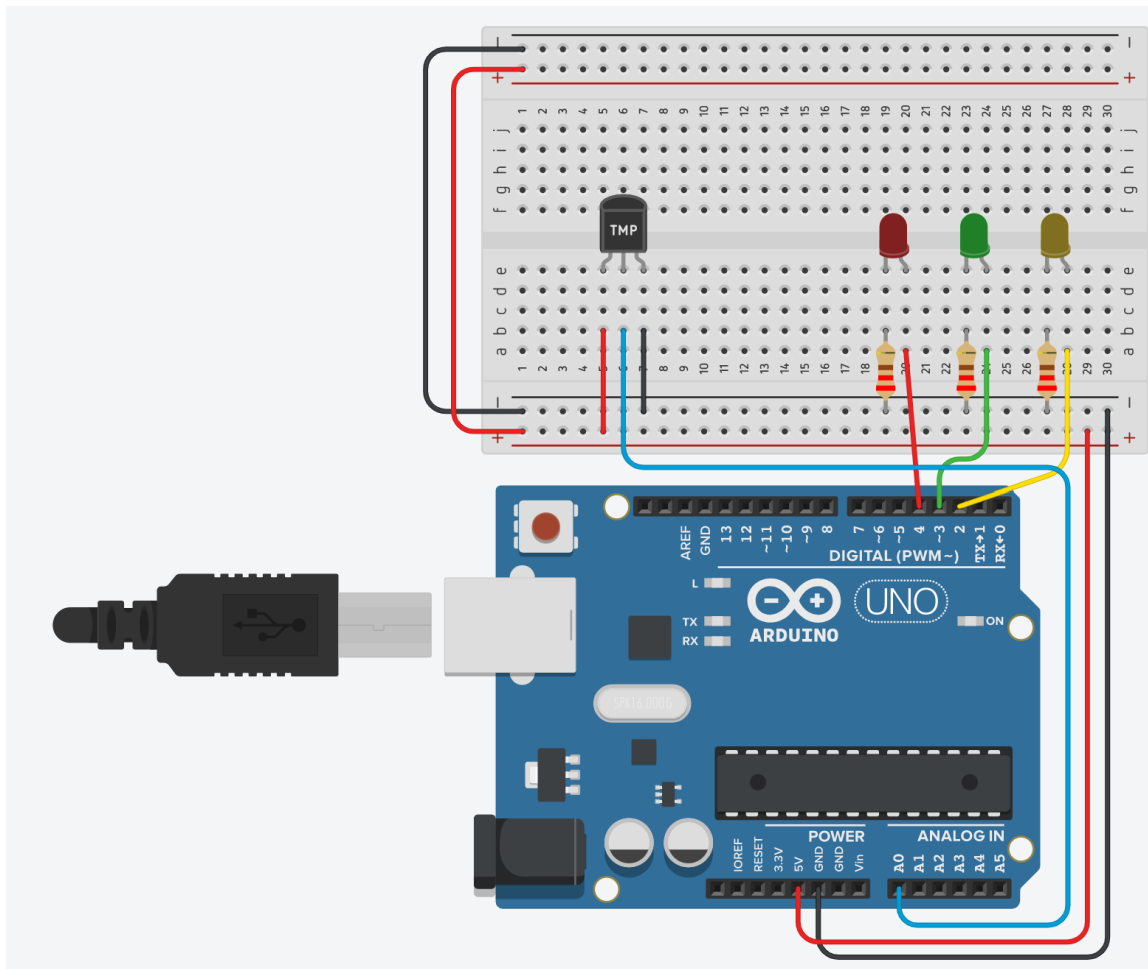
7. Add wire to connect the “5V” pin on the Arduino to one of the + power rails on the breadboard. Change the colour of the wire to red.
8. Similarly, add a black wire to connect the “GND” (Ground) pin on the Arduino to one of the - power rails on the breadboard.




Part 4: Build the Circuit

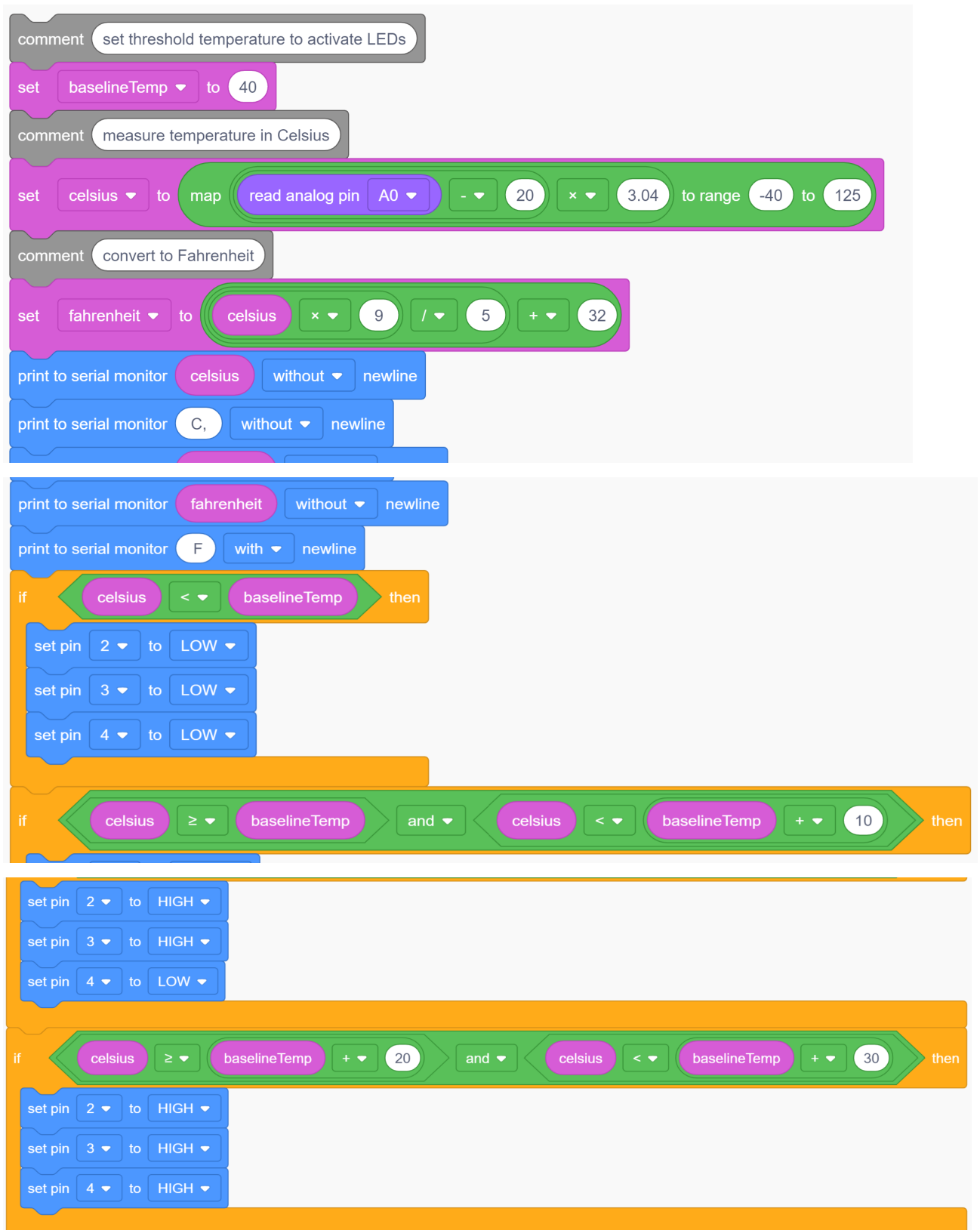
Refer to the diagram below when building the circuit.

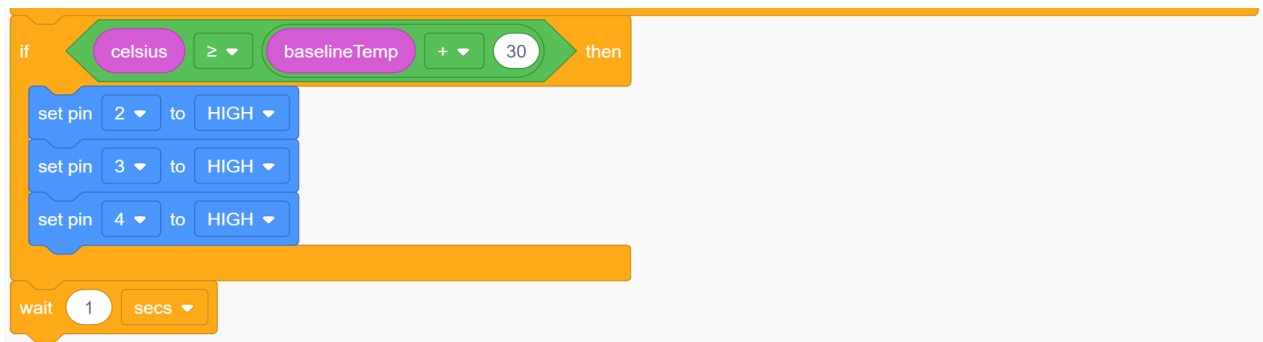
9. Connect the LEDs to row E on the breadboard. You can click on each LED and change the colour.
10. Connect each resistor to each LED's cathode (left leg) to the ground rail of the breadboard. Connect each LED's anode (right, bent leg) to digital pins 4, 3, and 2 on the Arduino board.
11. Connect the TMP36 temperature sensor to row E on the breadboard.
12. Connect the left leg of the TMP36 sensor to the + power rail on the breadboard. Connect the right leg of the sensor to the - power rail. Then connect the centre pin to A0 pin on the Arduino board.



Part 5: Adding Code

13. We will now add code to our electrical circuit by clicking on the  Code symbol.
14. We want to detect the temperature and light up the LEDs depending on the temperature. We want all 3 LEDs to light up when it is really hot, 2 LEDs to light up when it is warm, and 1 LED to light up when it is cool.
15. Add the code similar to the diagram below by drag and drop appropriate code blocks.
16. To create three new variables named baselineTemp, celsius, and fahrenheit: click “Variables”, then “Create variable...”.





17. You can now click on “Start Simulation” and see how your circuit behaves.
18. You can change the temperature range in the “if” statements to see a more obvious change in the lights.

Extension

Research how the TMP36 sensor measures temperature. It is a fairly easy to use sensor and can measure temperature over the -40 Celsius to 125 Celsius temperature range.

Reflection Questions:

- Are there any improvements you would make to this challenge? Was this challenge easier or more difficult than you expected?
- In which projects/circuits would a TMP36 sensor not be a good sensor to use to measure temperature?
- Remove all 3 resistors from the circuit. Then connect the negative leg of the LED to GND (Ground). Did you get a notification as you simulate your circuit? In your own words, why do we need a resistor for this LED circuit?

Submission Guidelines:

- Submit a photo your circuit. 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>

Bibliography:

- Circuits and Instructables (2019) *TMP36 temperature sensor with Arduino in Tinkercad, Instructables*. Instructables. Available at:
<https://www.instructables.com/TMP36-Temperature-Sensor-Arduino-Tinkercad/> (Accessed: May 8, 2023).