Temperature

Grades 6-8

Lesson Overview

60 - 120 mins

During this lesson, students will design and code an experiment asking questions about data to learn about temperature and how different materials conduct heat. They will integrate Vernier sensors with Google Sheets and SAM Labs blocks.

Learn

Warm-Up
Mini-lesson

Identify what temperature is and how things get hot.
Explore the optimum temperature for food and washing.

Do

Guided Lab Part 1
Debug Activity
Guided Lab Part 2
Extension Activities

Design and **code** a program using a Temperature Sensor to collect temperature data, extending to visualize the data using additional hardware; to explain the use of logic blocks which provide different outputs based on temperature input.

Reflect

Wrap-Up

Reflect upon and **show evidence of understanding** of learning.

Standards Focus

NGSS MS-PS1.4, MS-PS3.3, MS-PS3.4, DCI: MS-PS1.A, MS-PS3.A, MS-PS3.B, CSTA Data and Analysis 2-DA-07, 2-DA-08, 2-DA-09

Equipment Required

SAM Labs RGB Light, Vernier Go Direct Temperature

Temperature

Learn

Warm-Up

“How do things get hot?”

Prior Knowledge Required

- Objects in contact with each other tend to reach the same temperature.
- Kinetic energy is related to how fast an object is moving
- Matter is made up of atoms

Key Information

- Temperature is a measure of the average kinetic energy of molecules in a substance
- Heat is the movement of energy through
    - Conduction
    - Convection
    - Radiation
- Substances differ in how fast they transfer heat
- Heat moves from hot to cold

Unplugged Activity

- Using Think Pair Share, students can discuss the questions on the slides, using the images as prompts.
    - How do things get hot?
    - Where do you see heat transfer in the world around you?
    - What materials transfer heat quickly or slowly?
- Students can complete an paired/independent KWL chart to record their prior knowledge, establish questions and set expectations for recording learning at the end of the lesson

Link Forward

Students learn about the process of conduction and observe how different substances conduct heat at different rates.

Mini-lesson

How does conduction work?

Key Information

- As the motion of atoms and molecules speeds up, the temperature of the substance increases.
- In conduction, faster-moving molecules collide with slower-moving molecules and transfer energy to them.
    - The fast molecules slow down (cool).
    - The slow molecules speed up (heat).
- Energy is transferred from a substance at a higher temperature to a substance at a lower temperature.
- Some materials are better conductors of heat than others. Insulators are substances which do not readily allow the passage of heat.
    - Examples of Conductors: metal (gold, silver, copper, aluminum, etc.)
    - Examples of Insulators: wood, styrofoam, air, cloth and paper etc.

Unplugged Activity

- Students compare and contrast conductors and insulators using the slides.
    - Have students identify examples of various conductors and insulators.
    - In groups, have students identify an example of a conductor and an example of an insulator around them.
    - Have students feel their examples then discuss why the objects feel like they are different temperatures.
- Review the conversion from degrees Fahrenheit to degrees Celsius: $°C = (°F - 32) \times 5/9$
    - Have students complete the temperature conversion activity (on the slides) for washing their hands and drinking hot chocolate.

Note regarding Go Direct Temperature: The Go Direct Temperature sensor collects temperature data in units of Celsius. More details about Go Direct Temperature can be found here: https://www.vernier.com/manuals/gdx-tmp

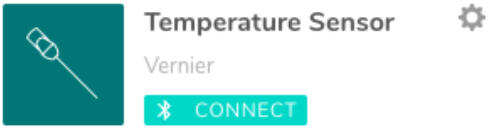
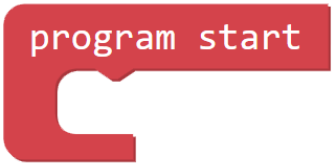
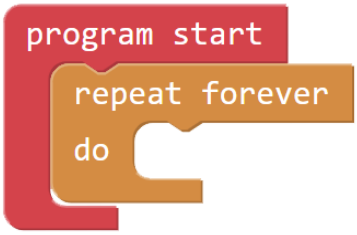
Link Forward

Students code a program to measure the temperature and turn on an LED to indicate a temperature range.

Do

Guided Lab - Part 1

Design and code a program that measures temperature.

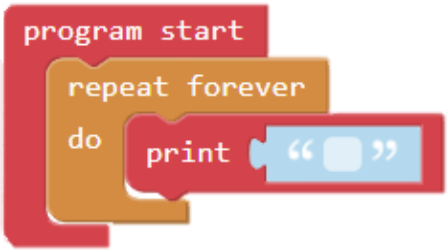
Instructions	Workspace
Step 1 Click 'ADD DEVICE' and select: ● 'Temperature Sensor'	
To connect the Sound Sensor, click 'CONNECT' and 'Pair'.	**The sensor is paired when it appears under your 'Connected Devices' menu on the left hand side of the screen.** **The Go Direct Temperature Sensor power button is the soft depression in the middle of the handle of the sensor.** **Some tips for connecting to Vernier sensors:** ● **In the sensor list, sensors are identified by sensor order code and ID number, e.g. GDX-TMP 0F1092B4 for Go Direct Temperature sensor.** ● **Vernier Go Direct sensors connect wirelessly via Bluetooth technology, which is a 1-to-1 pairing process. Each sensor can only be connected to a single device (computer/Chromebook). Once one student has connected to a particular Vernier sensor, it will drop off from everyone else's sensor list.**
Step 2 From 'General', drag onto the workspace: ● 1 'program start' block	
Step 3 From 'Loops', drag onto the workspace: ● 1 'repeat forever do' block. Snap into the 'program start' block.	 **Ensure students understand that the 'repeat forever do' block will run all code within it until the program is stopped.**

Temperature

Step 4
From ‘General’, drag onto the workspace:

- 1 ‘print [“ “]’ block.

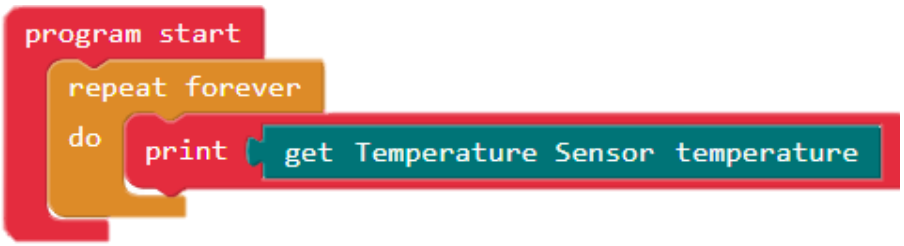
Snap into the ‘repeat forever do’ block.



Step 5
From ‘Temperature Sensor’, drag onto the workspace:

- ‘Get Temperature Sensor temperature’ block

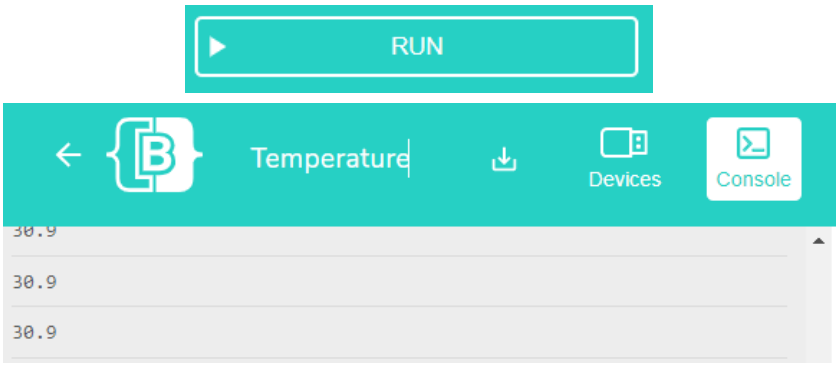
Snap into the ‘print [“ “]’ block.



The print function allows you to log and view data

Step 6
Run your program.

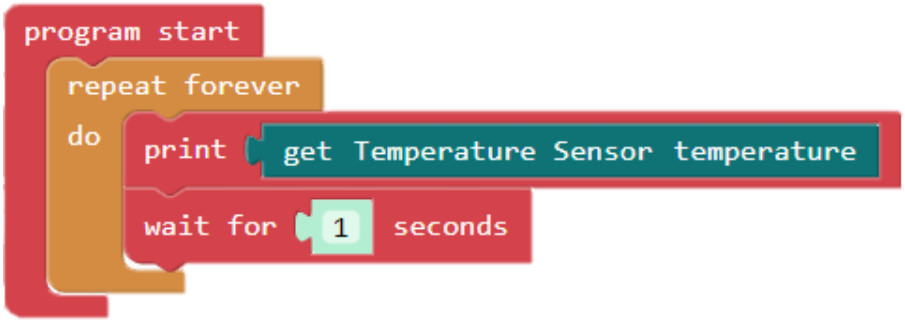
Test your program by clicking on the "Run" button at the top of the Programming Canvas.



Have students measure the temperature of the objects they tested by feeling with their hands

Debug Opportunity

The data is printed to the console too quickly. How can I slow down the readings to better understand the data?

Instructions	Workspace
Step 1 From 'General' tab, drag onto the workspace: • 'Wait for 1 seconds' block Snap under the 'print' block.	 **Encourage students to connect the results to the factors and/or variables introduced in the mini-lesson.**

Link Forward

Students code a program that changes the color of an LED in response to the temperature measured by the temperature sensor

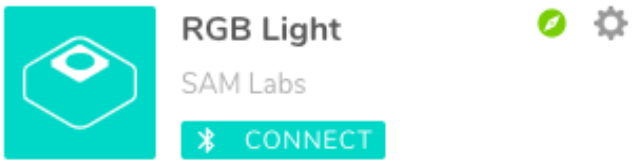
Guided Lab - Part 2

Design and code a program that changes the color of an LED based on the temperature measured by the Temperature sensor.

Instructions	Workspace

Step 1
Add the RGB Light: click 'ADD DEVICE' and select: 'RGB Light'

To connect the RGB Light, click 'CONNECT' and 'Pair'.



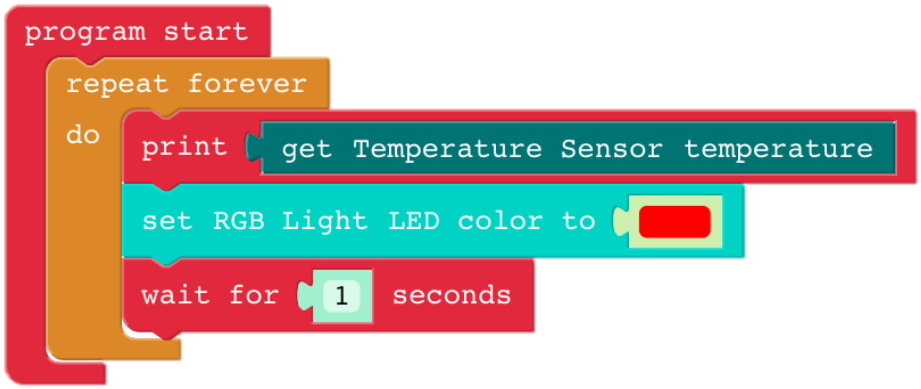
The sensor is paired when it appears under your 'Connected Devices' menu on the left hand side of the screen.

Teacher Note: When SAM Labs RGB LEDs are powered on but not yet connected to a device, their indicator lights will show red. In the Connection list the LEDs will show as "SAM RGB LED (...)" with a series of numbers and letters in the parentheses. Student groups can pair one-by-one or gather all of the LEDs in one place and have students just select a random LED from the Connections list. Once they've connected, its indicator light will turn teal.

Step 2
From 'RGB Light' tab, drag onto workspace:

- 'set RGB Light color to' block

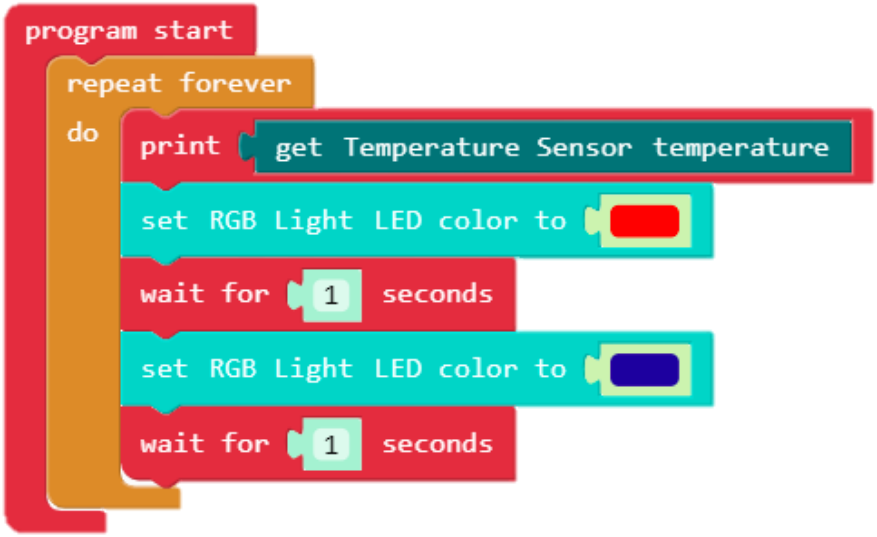
Snap Into 'do' position before the 'wait for... seconds' block.



Temperature

Step 3
Add another pair of the 'set RGB Light color to' block and 'wait for ... seconds' block at the end of the 'do' position.

Change colors so they are ordered red and blue.

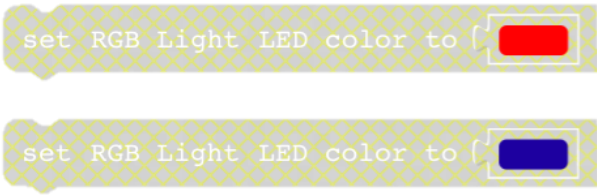


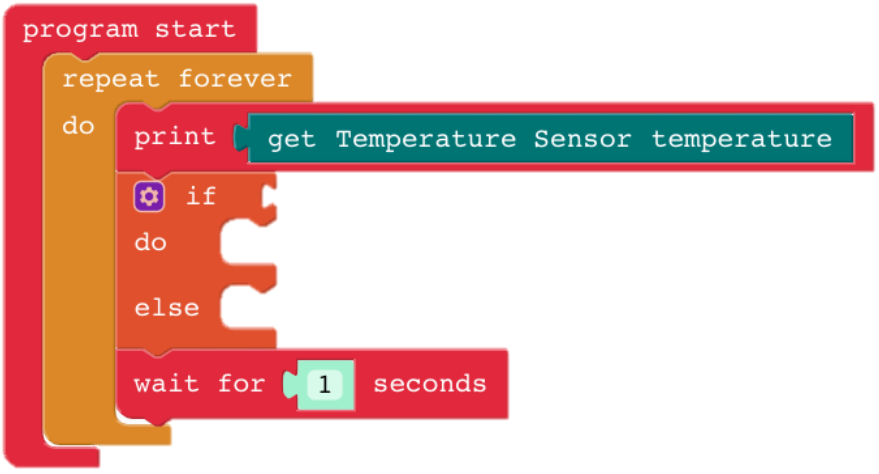
This program will print the temperature in the Console, turn the LED red for one second, turn the LED blue for one second and repeat the process. Encourage students to discuss if this is showing colors for different temperature levels. Lead students into discussing what block we need to add in order to set temperature conditions.

Step 4
Remove the 'set RGB Light LED color' blocks and the 'wait' blocks from the code.

From 'Logic' add an 'if do else' block. Snap it in place below the 'print' block.

Add a single 'wait' block below the 'if do else' block.



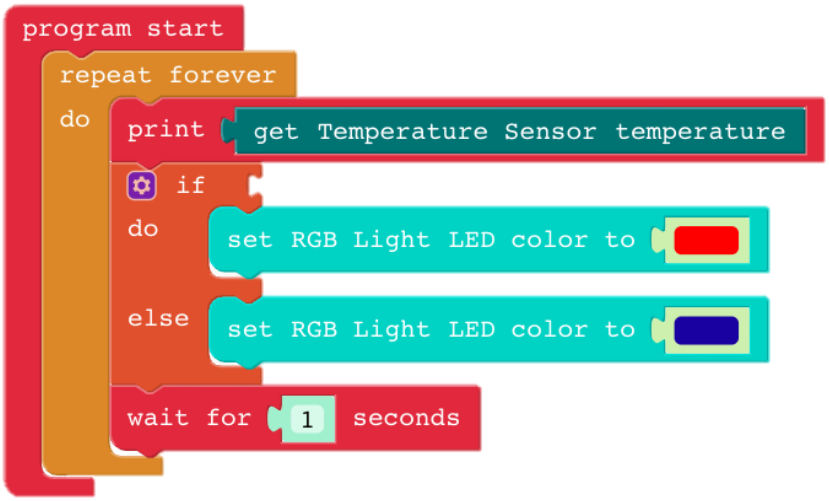


Students will use 'if do else' block to determine whether to turn on the red or blue LED.

Temperature

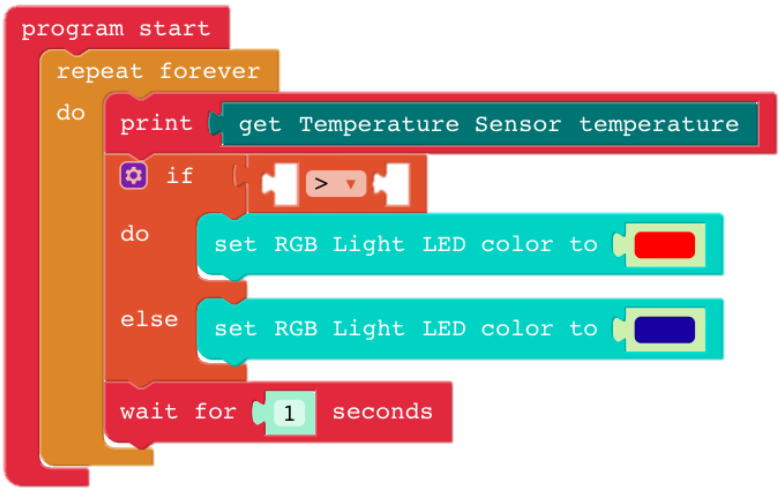
Step 5
Drag the 'set RGB Light LED color' blocks into the 'if else do' block.

Snap the red block into the 'do' position and the blue block into the 'else' position.



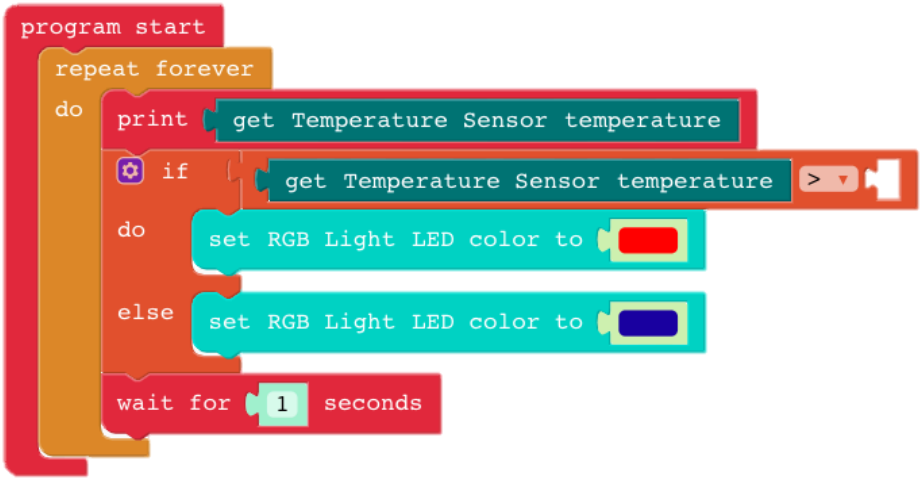
Step 6
From 'Logic' tab, drag onto onto the workspace:

- A '[]=[]' block. Click on the "=" and select ">" from the drop down list.



Step 7
From 'Temperature Sensor' tab, drag onto the workspace:

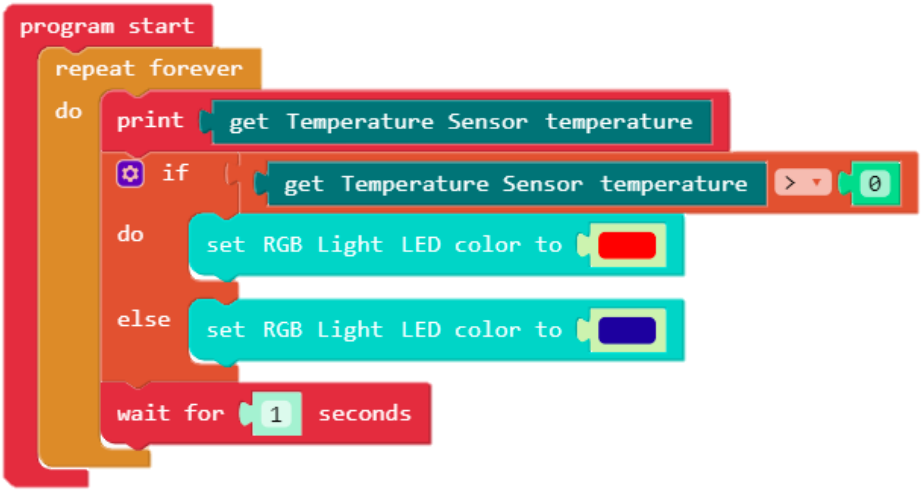
- 'Get Temperature Sensor temperature ' block
- Snap it into the first slot on the 'comparison' block



Temperature

Step 8
From 'Math' tab, drag onto the workspace:

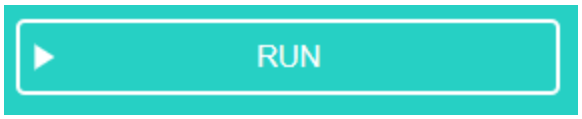
- A number block.
- Snap it into the second slot on the 'comparison' block
- Click on the "0" and change the value to a number slightly greater than the room temperature .



Step 9
Run your program.

Students can observe a live readout of the sensor by looking at the Devices tab and clicking on the meter icon (in the upper right corner of the Go Direct Temperature sensor.

Test your program by clicking on the "Run" button at the top of the Programming Canvas.



Link Forward

Students extend their program visualising the relationship between the sensor and the data.

Extension Activities

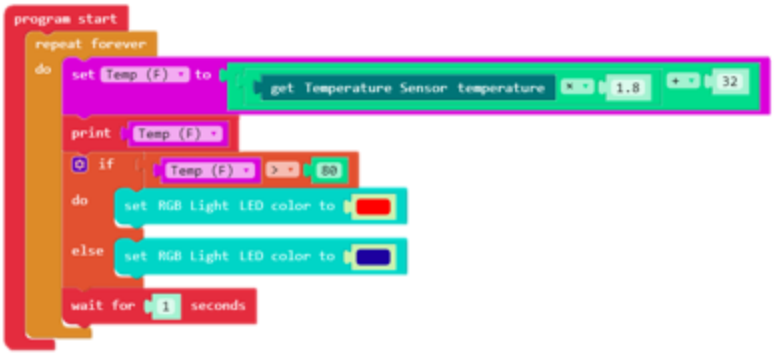
Modify your program to enhance display and output

Option 1 - Fahrenheit

Design Brief

Modify your code so that the temperature readings are displayed in Fahrenheit instead of Celsius.

Workspace



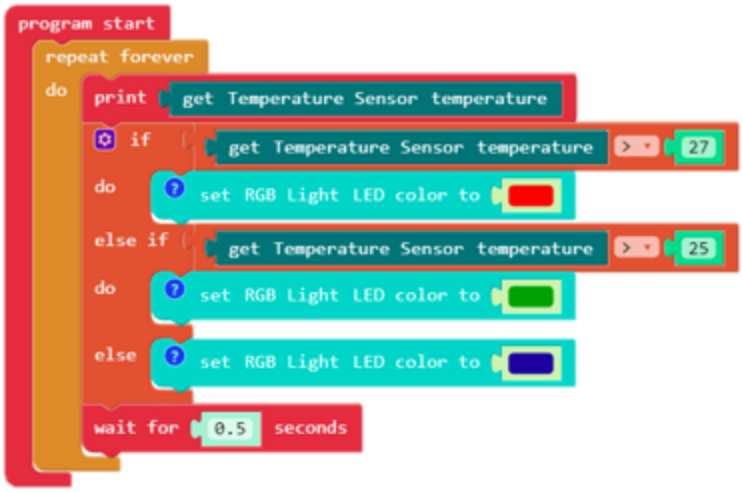
This shows example code that could be created to meet the design brief. This can be used to support students to develop their designs.

Option 2 - Three Temperature Ranges

Design Brief

Include a temperature range so that the optimum hand washing temperature makes the LED turn green

Workspace



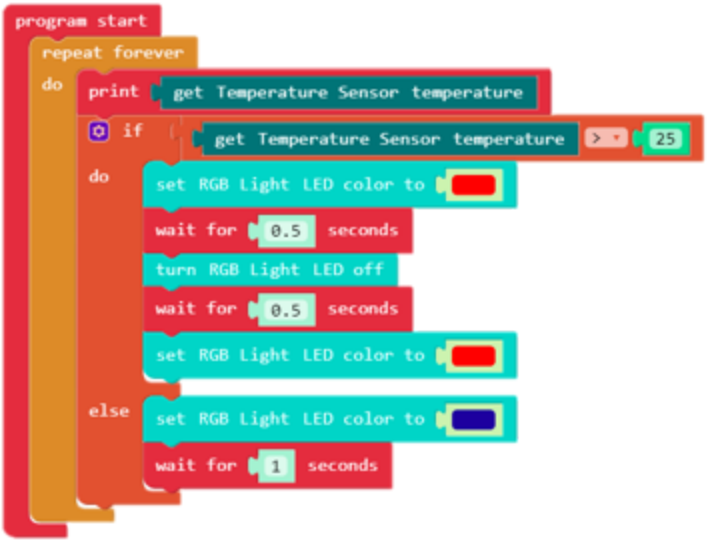
This shows example code that could be created to meet the design brief. This can be used to support students to develop their designs.

Temperature

Option 3 - Blinking Red LED
Design Brief

Modify your code so that the red LED blinks on and off when the temperature is above the limit you set.

Workspace



This shows example code that could be created to meet the design brief. This can be used to support students to develop their designs.

Reflection Prompts

How does the sensor help to demonstrate temperature more effectively than touch?

Why do you think some objects feel colder than others even though they are the same temperature?

Explain why rubbing your hands together makes them warmer.