Photon

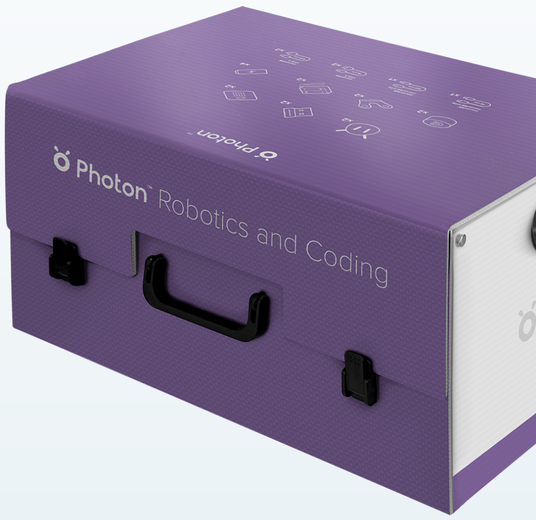
Robotics & Coding Teaching Kit

The Robotics and Coding Kit is a ready-to-use set of scenarios and accessories to conduct exciting and engaging computer science classes at the secondary school level.

The Kit comes with 15 dedicated lesson scenarios to help teachers decide on specific STREAM skills development in their students. Remember that the provided 15 ready-to-use scenarios are just the beginning. Combining the Photon Robot with the micro:bit and other components of your choice (e.g., RGB LEDs, humidity sensors) gives endless possibilities to teachers and students alike – the sky is the limit.

What's in the Kit:

- 2x Photon Robot
- 2x Magic Dongle
- 2x BBC micro:bit v2
- 2x Neodymium magnet
- 2x Mount to attach the micro:bit to the robot
- 2x AAA battery box + batteries
- 2x USB A - microUSB cables (short)
- 2x USB A - microUSB cables (long)
- 1x microUSB - microUSB OTG cable (short)
- 1x microUSB - microUSB OTG cable (long)



Why Robotics & Coding Kit?

The Robotics and Coding Kit has been developed in close cooperation with programmers, teachers, and professionals interested in education and teaching. The Photon Kit responds to the need for a universal teaching aid for computer science teachers focusing on STREAM competencies development. We combined a micro:bit mini-computer and our interdisciplinary Photon Robot to use all popular programming environments and to create a unique teaching kit for programming and robotics classes.

This combination opens up a whole new world of advanced and endless possibilities for students. Children can create and program their own devices, e.g., use Robot's built-in temperature sensor, sound detector, magnetic field sensor, etc. – this is just a tiny selection of what they can do!

Putting the Photon Robot to work with the micro:bit enables wireless serial communication with an unlimited number of devices and the ability to use several development environments. This Kit allows students to learn new practical skills, new programming languages, programming flexibility, and hardware solutions sought-after by employers.

Solutions and ready-to-use programs

Through the Teacher account, you have access to a section called “Ready Programs.” These are sample programming solutions for the projects provided in the Kit.

Programming Photon Robots and micro:bit mini-computers

Students can program both devices in one dedicated application. You can find it in the **Robotics and Coding** section of the Photon Magic Bridge app. You use separate programming logic for Photon and micro:bit – both programming interfaces can be displayed on one screen for convenience and be resized.

Teaching materials

The Kit consists of 15 lesson scenarios. Each scenario is a unique project. Students create new devices and learn about their real-life application or application of the related technology in everyday life. These teaching resources are provided in an electronic form (in PDFs, so you can easily print them at any time). All the resources become available in the Photon Magic Bridge app after logging in with an appropriate account.

For each of the 15 projects, there are two different types of resources:

- Lesson scenarios – available through Teacher accounts only.
- Introduction to classes – available through both types of accounts.

Scenarios are non-consecutive activities. You are free to conduct lessons in any order. Each lesson scenario is a separate project covering a different topic. This way, teachers can independently decide on the incorporation of the projects into their teaching schedule. Scenarios 1-3 are an exception, as they serve as an introduction to both devices included in the Kit and their integration. We recommend starting your work with the Kit with these 1-3 introductory scenarios.

Dedicated application

- Our dedicated application is available as an embedded module in the Photon Magic Bridge app for desktop computers. To download the Photon Magic Bridge, go to **photon.education/en/magic-bridge-download/**
- Please install it on all the computers in your lab. When you use the Kit, students can work in pairs or groups, depending on the number of workstations available. **No device connection is required for the app to work.** This way, students can exchange available equipment for program testing.

Separate Teacher and Student Accounts

- The app provides a choice of two types of accounts – for Teachers and Students. You can activate them on an unlimited number of desktop computers by entering unique codes included in the Kit.
- Both accounts give you access to programming interfaces. The primary difference is in access to teaching materials and project files / solutions.
- Important! To activate a Teacher account, you must register in the application first.

Title and Key Concepts	Learning Outcomes
Hello World Your first program for the Photon Robot	• To know the basics of the MakeCode environment in the Photon Magic Bridge application allowing to program the Photon Robot • To identify the correct connection status of the application with the Photon Robot • To create and test basic programs for the Photon Robot in the MakeCode environment
Micro:bit – Technology Miniaturization Your first program for micro:bit	• To get familiar with the MakeCode environment in the Photon Magic Bridge application used to program the micro:bit device • To create basic programs for the micro:bit device using the MakeCode interface • To upload and test the first applications to the micro:bit device
We Can Do More Together The Photon robot and the micro:bit communication interface	• To create programs that combine capabilities of the Photon Robot and micro:bit • To know the concept behind the serial transmission and practical use it (supports communication between devices using a serial port)
Obstacle Sensor Motion sensor relying on the Photon Robot data transmission	• To use variables • To practice mathematical operations on numbers and variables • To program a device using a working principle of a well-known device
Weather Station Weather station (monitor changes in temperature with the Robot's ears color)	• To know how to use if...else and if conditional statements • To use gained knowledge in practice by designing a weather station
Photon on a Leash Manipulator / Remote control for the Photon Robot	• To give examples of device manipulators • To design and program a control device (manipulator/remote controller) • To use variables and loops in programming
Dimmer Light intensity controller (dimmer)	• To use the if condition • To use the minimum and maximum permissible range of values for a variable • To implement the RGB color model in practice
Remote Commands The Photon robot wireless remote controller (using two micro:bits)	• To distinguish and implement wired and wireless communication • To make informed decisions when selecting commands from the Movement section to achieve the desired project objective

Title and Key Concepts	Learning Outcomes
Welcome Home (IoT Element) Multi-resident home activity recognition (using two micro:bits)	• To distinguish and implement wired and wireless communication • To use wireless communication – radio-based (between micro:bits) and wired communication (between the robot and micro:bits) • Program a trusted resident detection system
Magnetic Field A device that sets the Photon Robot in motion by strong magnetic field deflection	• To use the micro:bit's magnetic field sensor • To calibrate the magnetic field sensor and interpret the readings • To program the micro:bit device with a built-in magnetic field sensor to set the Photon Robot in motion after detecting a strong magnetic field deflection.
Backup Light Build a self-driving vehicle with a reversing sensor (use hazard warnings of your choice)	• To give examples of self-driving robots • To use programming loops, if...else conditions, variables, commands responsible for sound and the robot's LED light
Tea Time A countdown timer for tea brewing (with audiovisual cues)	• To use of time as an operational variable in various devices • To use of commands responsible for time, variables, logical operators, functions, sounds, lights, and others
Multi-sensor Alarm An alarm system using various sensors and Kit components	• To Indicate the different types of alarms and their uses • To use if...else conditions, variables, logical operators, sensors related commands, sounds, lights, etc.
Music Score (Sheet Music) A prototype that allows to read black symbols off white surfaces and transcribing them into audio signals	• To interpret sensor readings • To design new data entry interfaces for each device
RGB Lights Color changing controller for the Photon Robot (based on readings from the built-in accelerometer)	• To know working principle of an accelerometer • To implement advanced commands from the Text category (for micro:bit) to combine messages • To use if...else conditions, variables, logical operators, join texts in communication

Lesson scenarios – Teacher's guide

Lesson plans are ready-to-use resources to help you prepare for your classes. The introductory section outlines objectives, required materials, and a brief description of each project. Some resources have an additional "Before the class" section where we suggest topics/materials worth introducing beforehand. Most lesson scenarios have the following structure:

- **A brief introduction to the topic** – discussion on selected technologies.
- **Important instructions** – overview of programming blocks (instructions) that might be useful in the project. Here the focus is on specific instructions related to the Photon and micro:bit integration. The scenarios assume that students have basic programming skills (defined below). Please make sure to introduce students to the basics of programming before the project, if necessary.
- **Project overview**
- **Working on projects in groups**
- **Presentation and discussion of sample solutions**

If you are working with less advanced groups, you can begin the hands-on part by providing students with completed projects. Ask students to analyze each design concept and understand the logic behind each project. Then focus on the project development potential and modifications.

You could also find a "Tips / Discussion topics" section and "Related resources" section with suggestions on the project development in the lesson scenarios.

Introduction

Our dedicated app comes with slides that explain the concept behind the provided lesson scenarios. They illustrate the introduction sections' content, list assumptions for the project, and provide implementation tips. Each presentation also contains a question/hint to encourage students to expand their knowledge on a given topic. Teachers can use them at the introduction stage. Students can use them at the group work stage.

Before you start working with the Kit, your students should:

- Have some basic experience in working with a VPL (visual programming language, e.g., Scratch, Microsoft MakeCode, Blockly).
- Be able to create algorithms using sequences of instructions, conditionals (if-else), loops with iteration, variables.

The whole Kit is based on these competencies and helps to develop them.

Scenario: Weather station

Goals:

Students will be able to:

- Know how to use if...else and if conditional statements
- Use gained knowledge in practice by designing a weather station

Project description:

- Weather station (monitor changes in temperature and signal them by changing Robot's ears color)

Required items:

- The Photon Robot x2
- Photon Magic Dongle x2
- micro:bit x2
- Computers
- Projector or interactive whiteboard
- Cabling (included in the kit)
- Hair dryer (optional)

Ready Programs

(available in the MakeCode editor):

- Photon: 05 Weather station
- micro:bit: 05 Weather station

Introduction:

Introduce students to the concept of using the micro:bit controller as a temperature sensor. Use a projector or a different display to explain the Temperature block from the Input blocks' category and show the temperature sensor location. Pay particular attention to these issues:

- This is not a typical temperature sensor, but a sensor that monitors the micro:bit's processor temperature. In principle, the micro:bit's processor does not heat up much during operation, hence, you can easily use it as an ambient temperature sensor.
- The temperature reading is in degrees Celsius (the block returns only a numeric value).
- Please also explain the communication method between the micro:bit and the Photon Robot. In general, data sent over the serial port between these devices should be treated as string data, i.e. text data. Therefore, if you want to use the data as numbers you need to use the convert text to numbers command (in MakeCode see **Advanced / Text / Parse to number [floating point number]**). In computer science, as well as in physics, we compare only comparable data (we are not able to compare cm to kg. The same here, we compare text data with text data, and numerical values with numerical values).

Learning activity:

- Recap on students' previous experience with visual programming environments (Scratch, Blockly), and remind them how the if...else if loop works.

Divide students into groups and present the project objectives:

- The expected result is a programmed Photon Robot connected to the micro:bit. The devices should work in tandem as a quasi-weather station.
- At a given frequency (e.g., every 10 or 30 seconds) the micro:bit should send temperature data via the serial port to the Photon Robot.
- Micro:bit stores the highest and lowest temperature values (as two separate variables).
- When you press the micro:bit logo, the actual temperature reading is sent via the serial port and is also briefly displayed on the device screen.
- When button A is pressed, the lowest stored temperature reading is sent via the serial port and briefly displayed on the device screen.
- When button B is pressed, the highest stored temperature reading is sent via the serial port and briefly displayed on the device screen.

NOTE! To demonstrate the desired result, you might want to present your students our animation or encourage them to analyze it independently – see student-ready resources (Introduction to Classes).

The Photon Robot should react according to temperature readings:

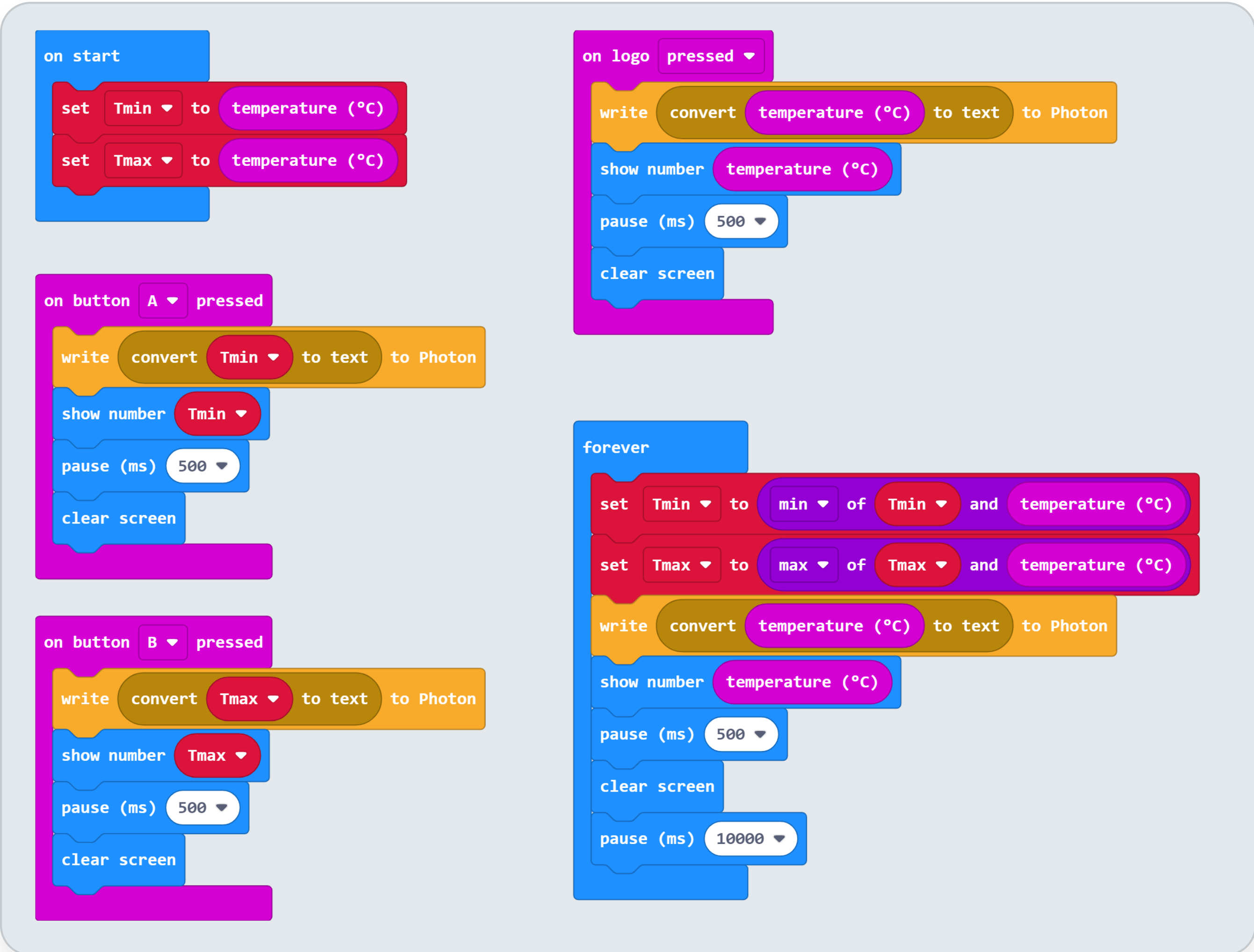
- temperature <= 18°C blue eyes and ears
- temperature <= 20°C blue eyes and light blue ears
- temperature <= 22°C light blue eyes and ears
- temperature <= 24°C orange eyes and light blue ears
- temperature <= 25°C orange eyes and ears
- higher temperatures = red eyes and ears

- When explaining the project objectives, please pay attention to the issue of the so-called initial status. It is worth defining the initial state of the Photon Robot, e.g., the color of its eyes and ears set to white (before receiving any temperature information). This way, users can tell that the robot has not yet received any input data.
- Once these initial assumptions are established, students begin working on their projects. They work in pairs or groups, writing two scripts (one for the Photon Robot and one for the micro:bit). Students can work at their computer desks without having to work in direct contact with the robot and micro:bit. They need both devices only when they are testing their solutions. To do that, they need to upload a script to the micro:bit and connect the robot to their computer. Supervise students and support them in finding the right solutions.

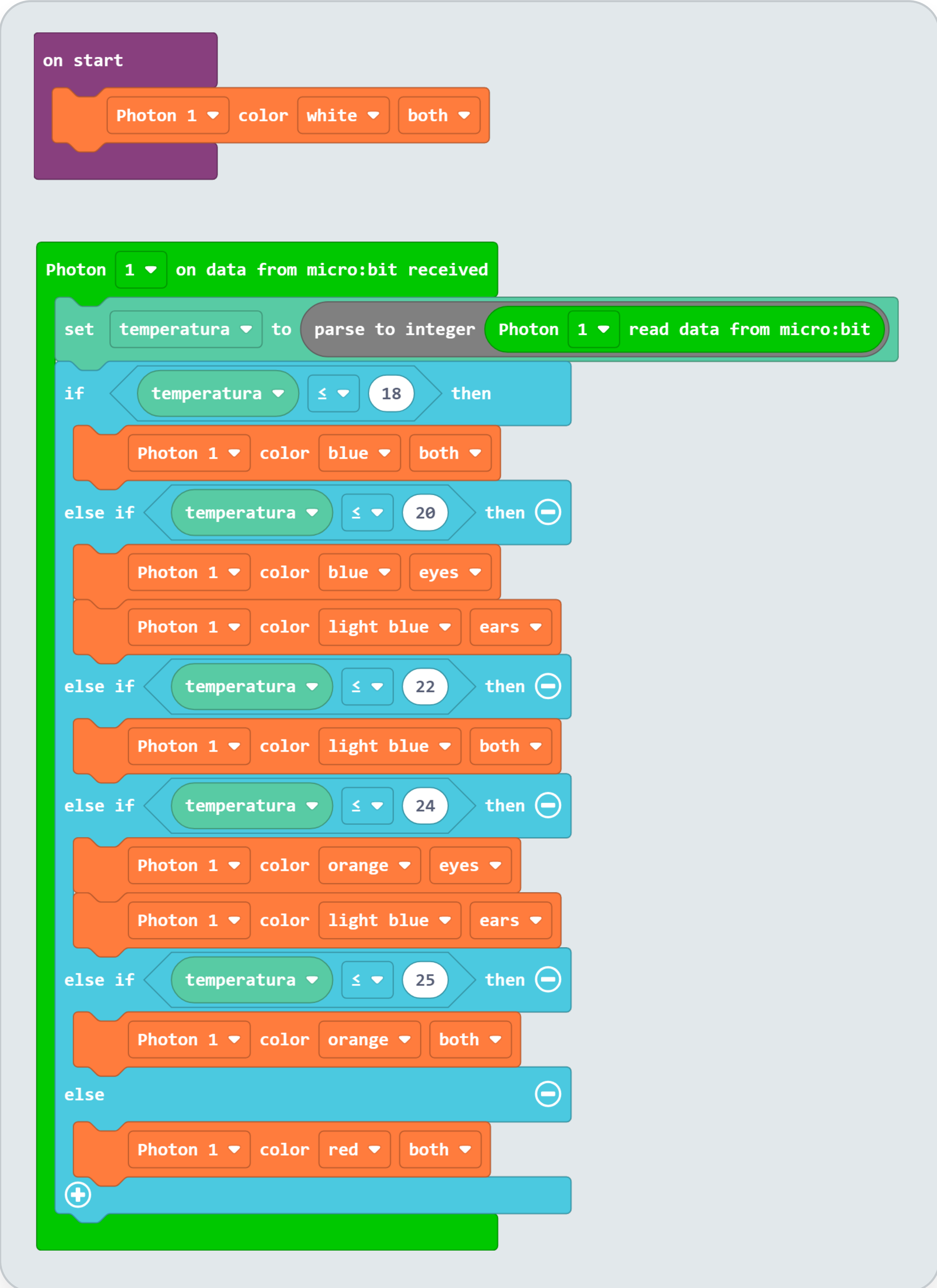
- Ask volunteers to present their solutions. Analyze both, the program performance (execution, outcome) and the script.
- You might also present and discuss your own solutions (or rely on the ready-made scripts in the appendices).

Tips / Discussion topics:

- Temperature variation testing in a classroom can be further facilitated by checking readings by a heat source (a radiator), room temperature after opening a window, after warming up the micro:bit in your hands. Alternatively, use indirect air blow from a hairdryer (switching between the hot and cold air stream).
- Does the order of conditions if...else if in a loop make any difference in the Photon's programming environment?
- What is required to correlate colors and temperatures that are expressed in the Fahrenheit scale (°F)?



Script micro:bit: 05 Weather station



Script Photon: 05 Weather station