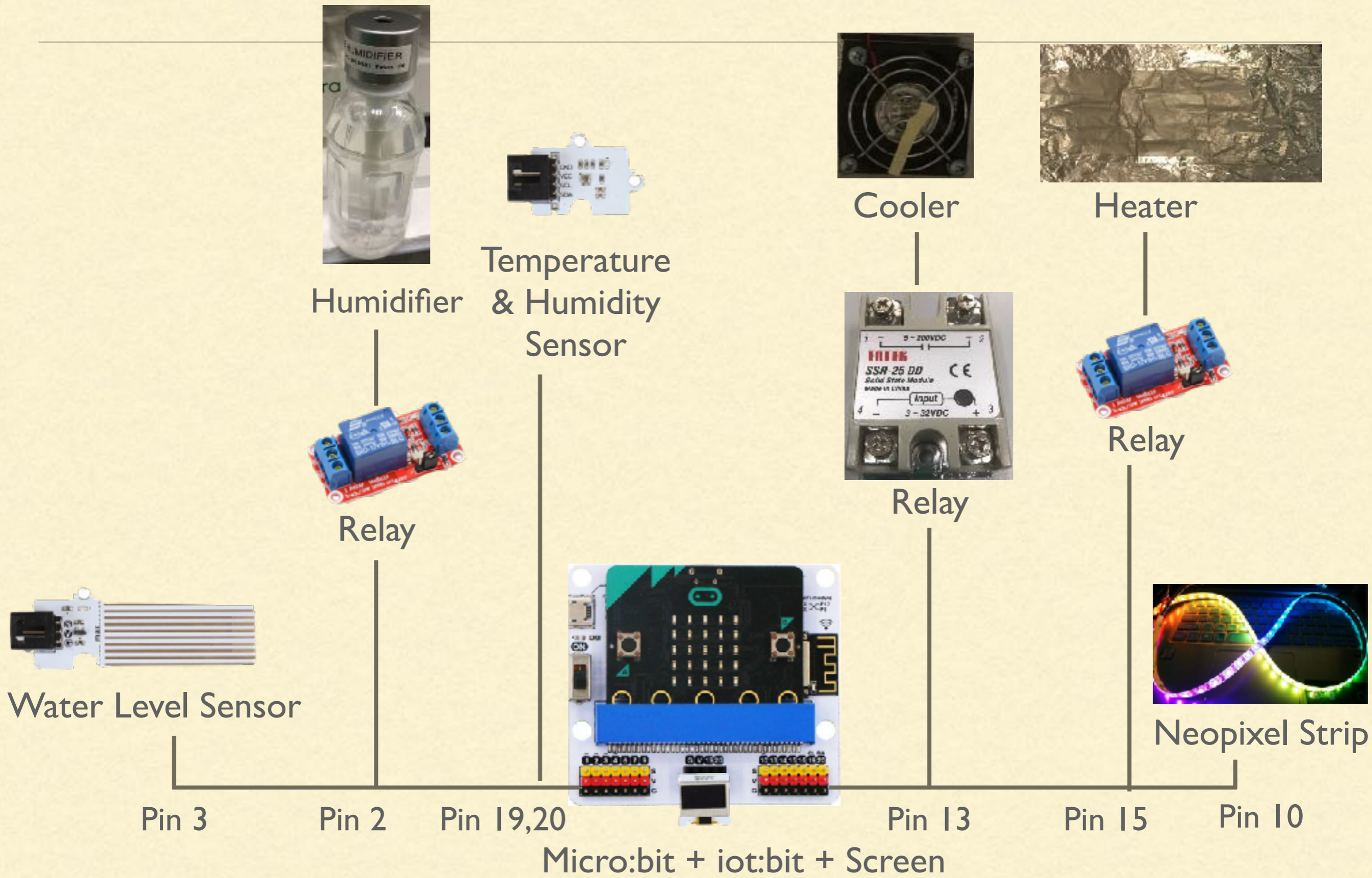

HYDROPONIC DEVICE

WHAT DOES THE HYDROPONIC DEVICE DO?

- Facilitate plant growth with different colours (spectrum) of light
 - Control and monitor humidity
 - Control and monitor temperature
 - Monitor water level
-

WHAT PARAMETERS COULD BE CHANGED?

- Colors of light (micro:bit code)
 - Threshold of temperature to trigger responses of cooler and heater (micro:bit code)
 - Threshold of humidity to trigger response of humidifier (micro:bit code)
 - Threshold of water level that will trigger email response (Thingspeak)
-



Hydroponic Device Block Diagram

HOW DOES DIFFERENT COLOURS OF LIGHT AFFECT PLANT GROWTH?

- The hydroponic device could show different colours by changing the micro:bit codes
- In our demonstration, we will provide the plant with red, blue, and purple light only

BENEFITS OF BLUE LIGHT

- Blue (450 nm to 495 nm)
 - Photomorphogenesis -> has an effect on photosynthesis -> more exposure to this light can increase plant's growth and maturity rates -> important for seedlings and young plants
 - Influences the formation of chlorophyll -> enables the plant to take in more energy from the sun
 - Controls a plant's cellular respiration
 - Lessens water loss through evaporation during hot and dry conditions
 - Help seed germination, ensure robust growth for roots, stems, and leaves
-

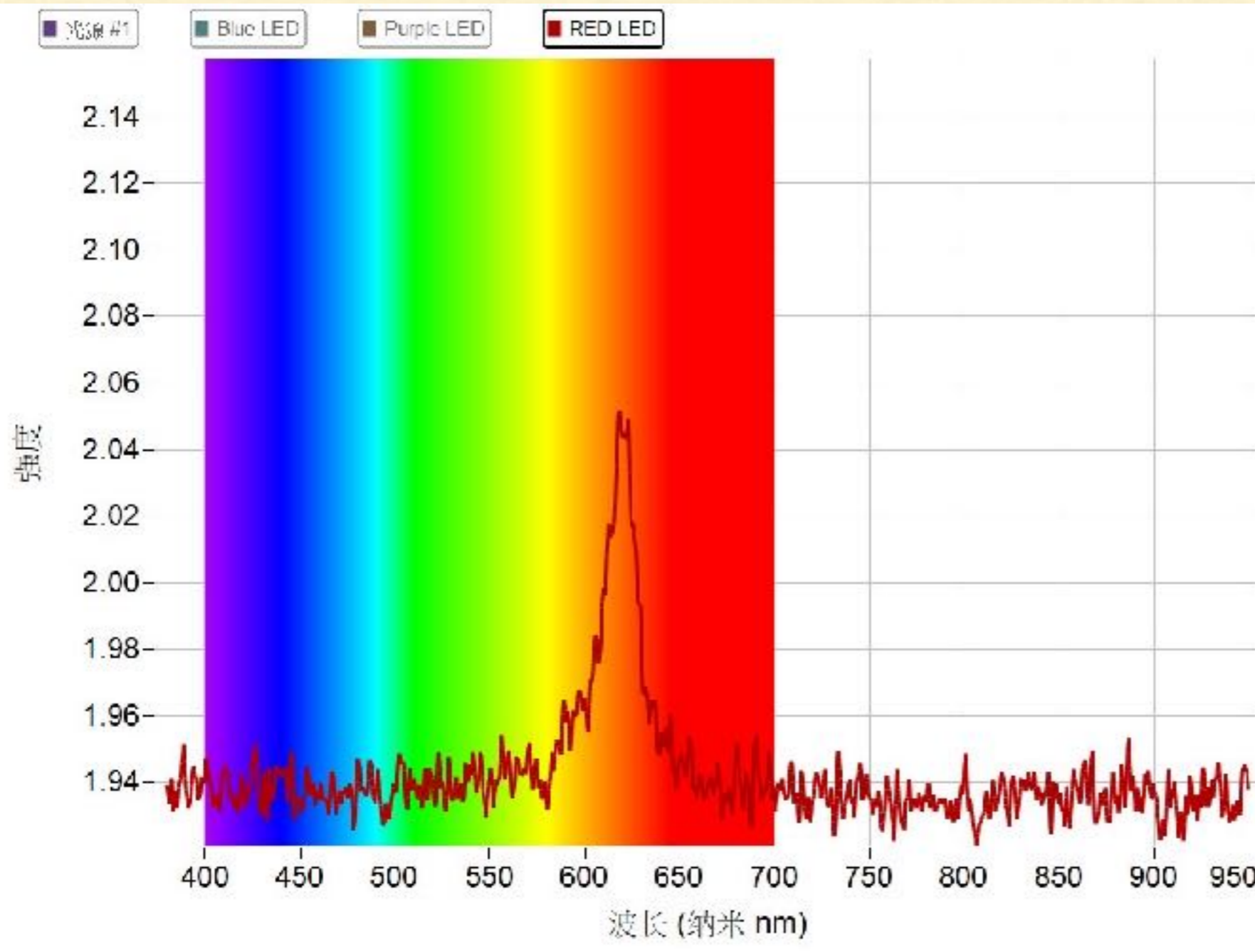
BENEFITS OF RED LIGHT

- Helps flowers bloom
 - a study by Michigan State University floriculture extension team found that if plants are grown only using red light, they'll have a stretched, elongated appearance, and their leaves will become thin and large
-

BENEFITS OF PURPLE LIGHT

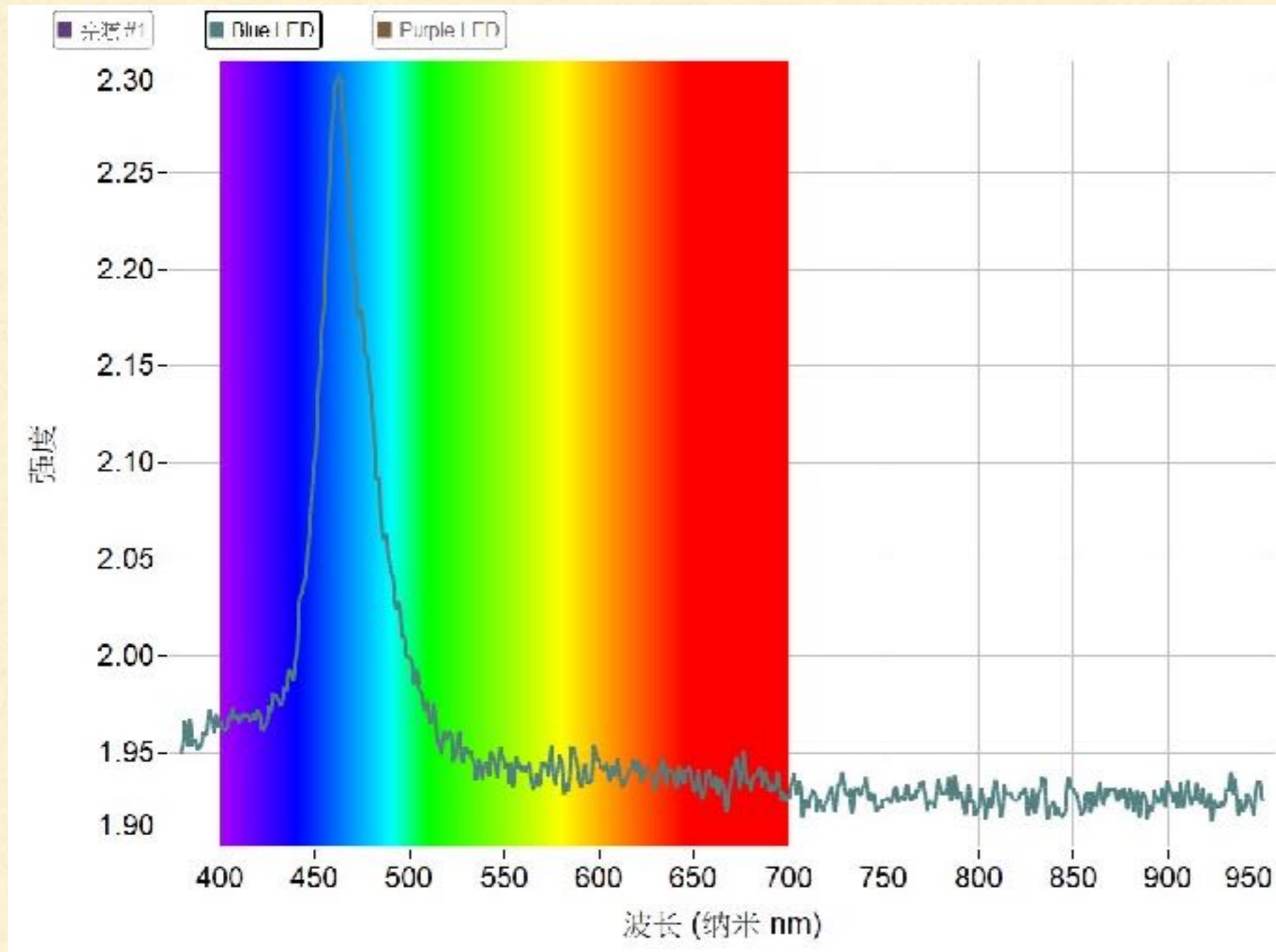
- Helpful for mature plants
 - Greatly increase amount of leaves that a plant grows
 - Allow plants to grow much healthier, with a compact appearance
-

SPECTRUM OF NEOPIXEL STRIP



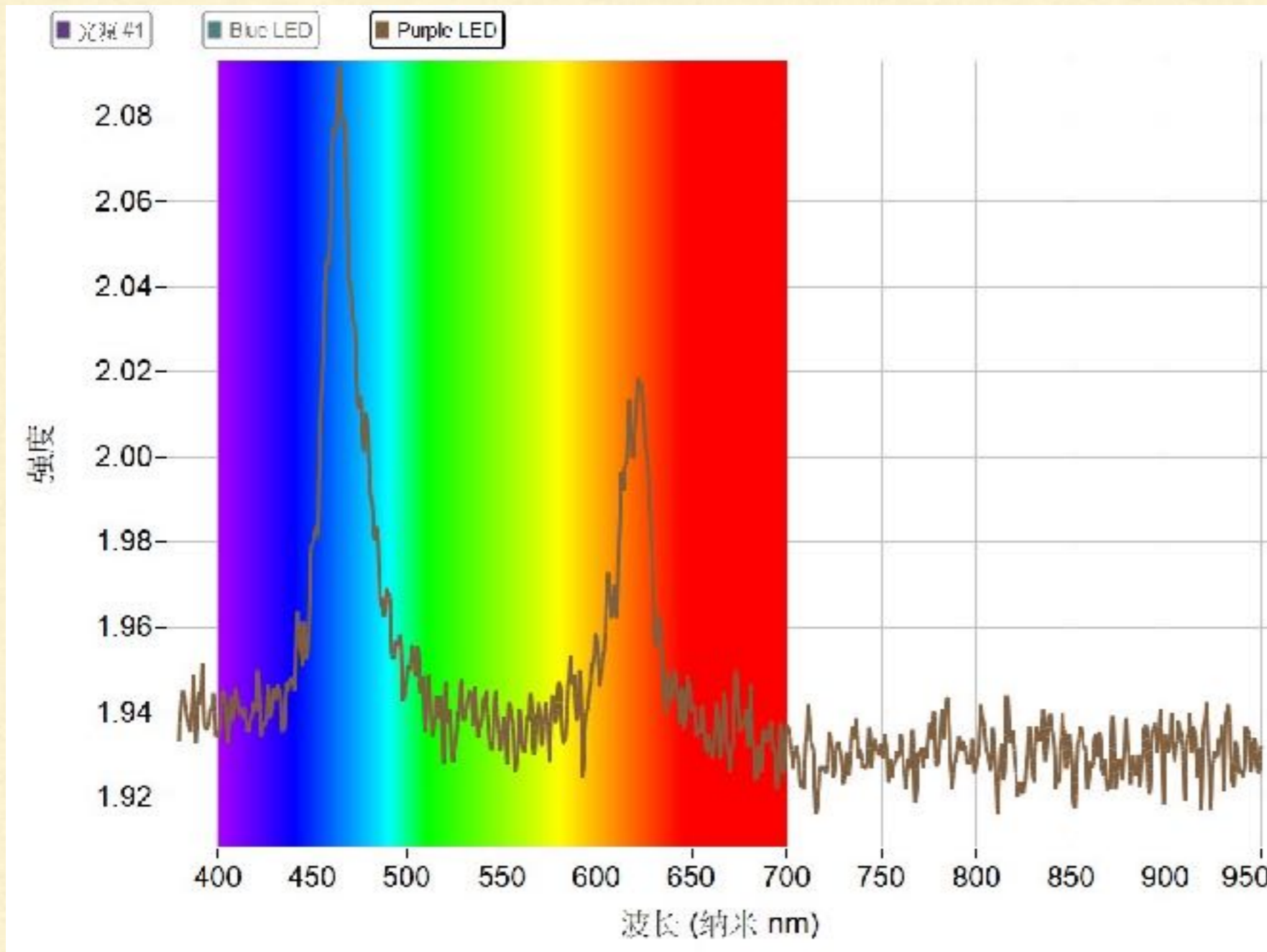
Red light peak
wavelength:
620nm

SPECTRUM OF NEOPIXEL STRIP



Blue light peak
wavelength: 462 nm

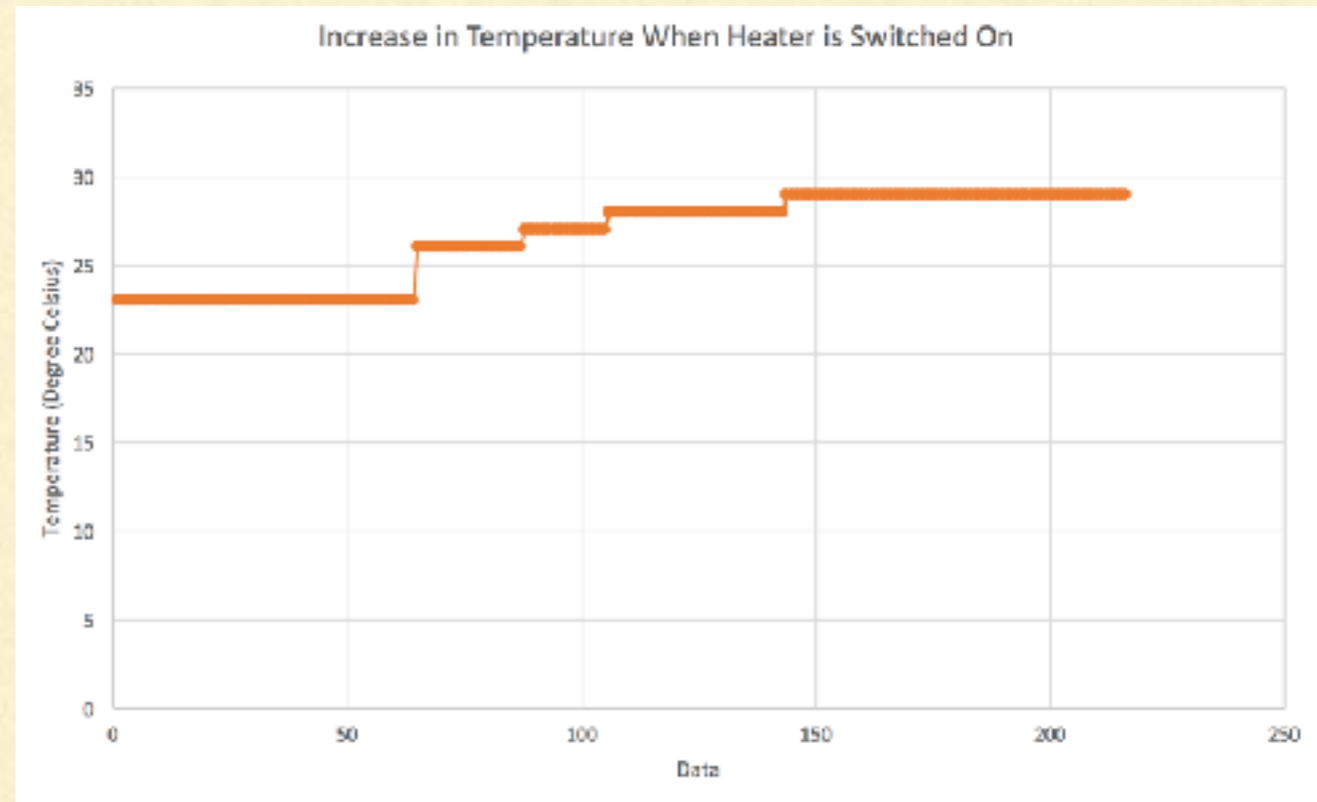
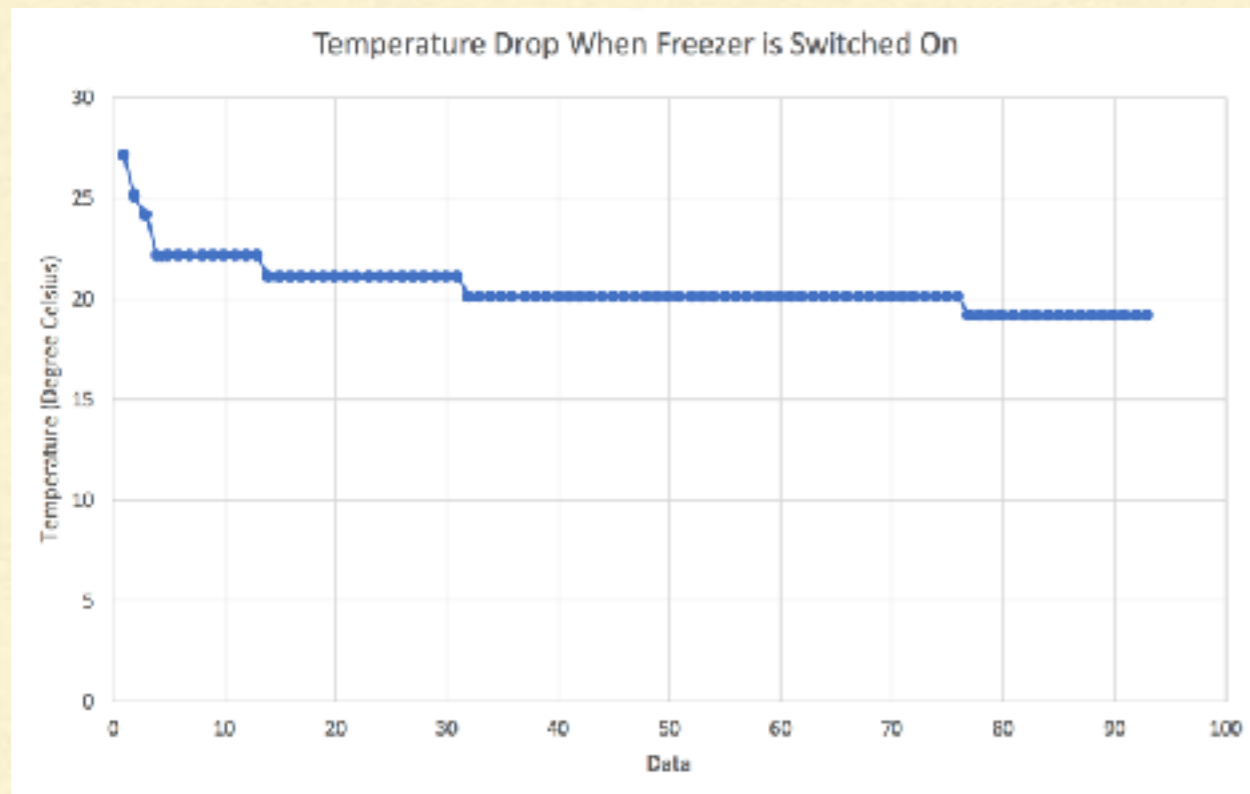
SPECTRUM OF NEOPIXEL STRIP



Purple light peak
wavelength:
464nm, 626nm

TEMPERATURE RANGE

- From 19 degree Celsius to 29 degree Celsius



To view the graphs of data from iot:bit, you could upload your data to the ThingSpeak IoT platform

- 1. Head to ThingSpeak website (<https://thingspeak.com>)
- 2. Register for a MathWorks Account
- 3. A MathWorks and a gmail account has already been set up for your school (the email and password are the same for both accounts)

Email: LSCCSTEM@gmail.com

Password: Aa246810

After signing into your MathWorks account, click on “New Channel” for your new project

Then, click on “Channel Settings”

Since our project has 3 parameters, namely humidity, temperature, and water level, we could put our parameters as our fields.

ThingSpeak™ Channels Apps Support Commercial Use How to Buy

My Channels

[New Channel](#) Search by tag

Name	Created	Updated
Hydroponic Device	2020-05-13	2020-05-13 07:24

Private Public Settings Sharing API Keys Data Import / Export

Help

Collect data in a ThingSpeak channel from a device, from another channel, or from the web.

Click [New Channel](#) to create a new ThingSpeak channel.

Click on the column headers of the table to sort by the entries in that column or click on a tag to show channels with that tag.

Learn to [create channels](#), explore and transform data.

Learn more about [ThingSpeak Channels](#).

Examples

- [Arduino](#)
- [Arduino MKR1000](#)
- [ESP8266](#)
- [Raspberry Pi](#)
- [Netduino Plus](#)

Upgrade

Need to send more data faster?

Need to use ThingSpeak for a commercial project?

[Upgrade](#)

Blog | Documentation | Tutorials | Terms | Privacy Policy

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ThingSpeak™ Channels Apps Support

Private View Public View [Channel Settings](#) Sharing API Keys Data Import / Export

Channel Settings

Percentage complete 30%

Channel ID 1059063

Name

Description

Field 1

Field 2

Field 3

Help

Channels store all the data in the fields that can hold any type of data. Once you collect data in a channel, you can view it in the channel's data table.

Channel Settings

- **Percentage complete:** Enter the percentage of data that has been collected in the channel. Enter the name of the channel.
- **Channel Name:** Enter the name of the channel.
- **Description:** Enter a description of the channel.
- **Field#:** Check the box if the channel can have up to 3 fields.
- **Metadata:** Enter information about the channel.
- **Tags:** Enter keywords for the channel.
- **Link to External Site:** Enter the URL of an external site.

Codes

Download `iot-environmet-kit` in extension

The screenshot shows the MakeCode Extensions page with a search bar containing 'iot'. A blue arrow points from the text above to the 'iot-environment-kit' extension card. The page displays six extension cards:

- iot-environment-kit**: Environment and Science IoT Kit for micro:bit. Includes logos for ELIZABETH, CLASSROOM, and TINKER ACADEMY. [Learn more](#)
- iot-lora-node**: Makecode Library for the Pi Supply IoT LoRa Node. [Learn more](#)
- minode**: mi:node kit(micro:bit IoT Starter Kit by element14) driver package for. [Learn more](#)
- wifi-shield**: MakeCode package for Muselab WiFi IoT Shield with micro:bit (beta). [Learn more](#)
- DFRobot-microIoT**: This is a micro:bit-based IoT expansion board with multi-. [Learn more](#)
- wifi**: MakeCode extension for WiFi:bit. Connect micro:bit to the Internet. [Learn more](#)

Codes

Runs when the program starts

```
on start
  initialize OLED with width 128 height 64
  set ESP8266 RX P8 TX P12 Baud rate 115200
  connect Wifi SSID = "your SSID" KEY = "your password"
  set strip_2 to NeoPixel at pin P10 with 50 leds as RGB (GRB format)
```

Initialise and set the size of the screen

Set up Wifi for iot:bit

Set your Wifi SSID and password

Set up the NeoPixel strip by choosing the number of LED you'd like to light up

https://makecode.microbit.org/_f10X8a8UPAfp

Then, click on “API Keys,”
and copy the “Write API
Key” as shown

The screenshot shows the ThingSpeak interface for a channel named "Hydroponic Device". The channel ID is 1059063, the author is mwa0000018479603, and the access is public. The "API Keys" tab is highlighted with a red circle. Below this, the "Write API Key" section shows a key "45GIK0617ZYPIRFL" with a red arrow pointing to it. A "Generate New Write API Key" button is also visible. The "Read API Keys" section shows a key "JR3QDI8MPMGCNKHL" and a "Note" field. The right sidebar contains a "Help" section with instructions on API keys and a "Write a Channel" section with a code snippet.

ThingSpeak™ Channels Apps Support

Hydroponic Device

Channel ID: 1059063
Author: mwa0000018479603
Access: Public

Private View Public View Channel Settings Sharing **API Keys** Data Import / Export

Write API Key

Key

[Generate New Write API Key](#)

Read API Keys

Key

Note

[Save Note](#) [Delete API Key](#)

Help

API keys enable you to... keys are auto-generated

API Keys S...

- Write API... been comp...
- Read API... feeds and c... read key fo...
- Note: Use... add notes t...

API Reque...

Write a Chan...

```
GET https://...&field1=...
```

Read a Chan...

Run this program forever

```
forever
  connect thingspeak
  set data to send ThingSpeak
  Write API key = "45GIK0617ZYPIRFL"
  Field 1 = value of BME280 humidity(0~100)
  Field 2 = value of BME280 temperature('C)
  Field 3 = value of water level(0~100) at pin P3
  Field 4 = 0
  Field 5 = 0
  Field 6 = 0
  Field 7 = 0
  Field 8 = 0
  Upload data to ThingSpeak
  pause (ms) 6000
```

Copy and paste the write API key from ThingSpeak here

Send readings from the temperature and humidity sensor to ThingSpeak

Send readings from the water level sensor to ThingSpeak

Wait for 6s for data to be sent to ThingSpeak

```
clear OLED display
```

```
show (without newline) string "Temperature: "
```

```
show number value of BME280 temperature(°C)
```

```
insert newline
```

```
show (without newline) string "Humidity: "
```

```
show number value of BME280 humidity(0~100)
```

```
insert newline
```

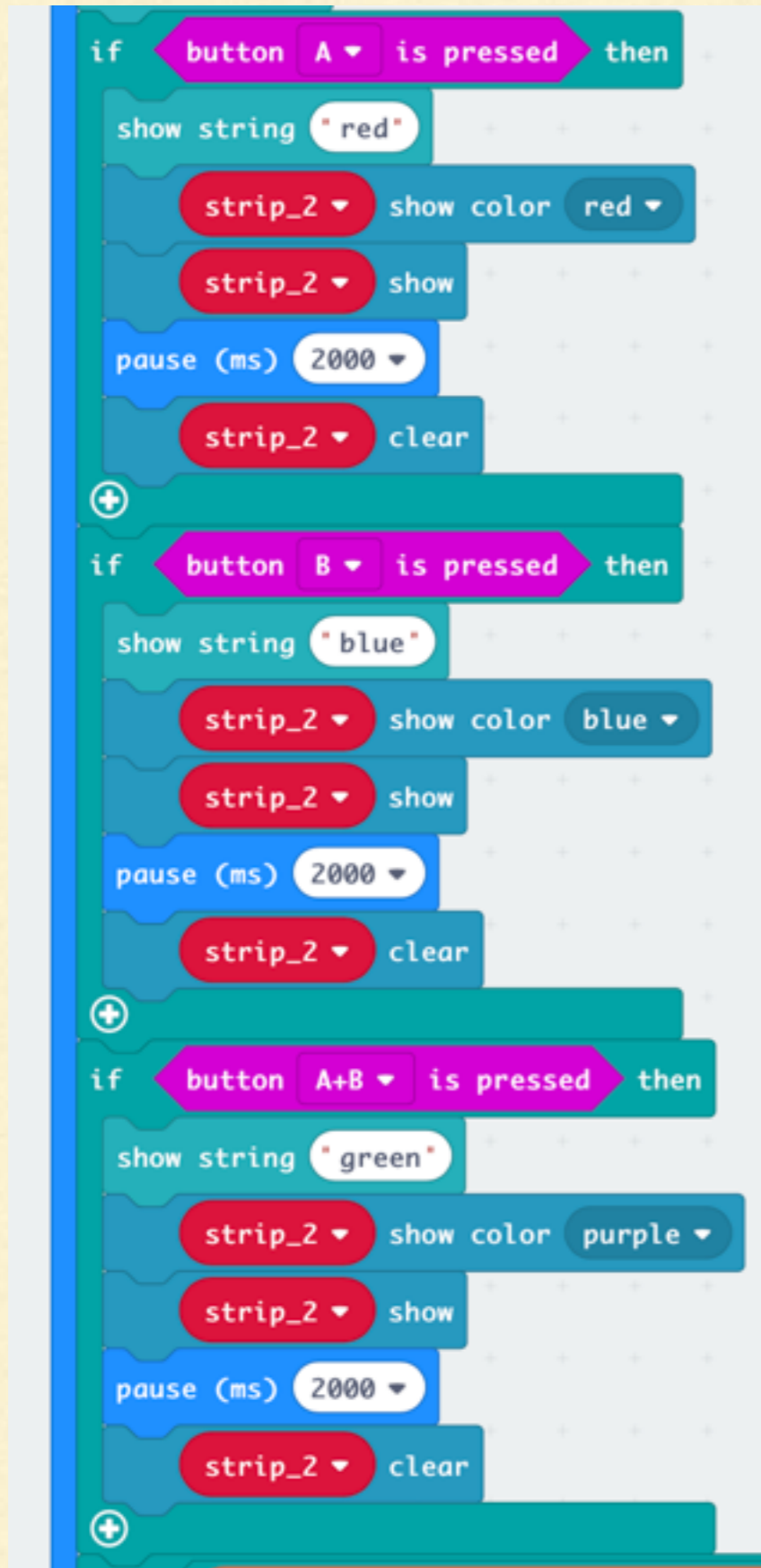
```
show (without newline) string "Water Level: "
```

```
show number value of water level(0~100) at pin P3
```

```
insert newline
```

On the OLED display (screen), show the word "Temperature," "Humidity," and "Water Level"

On the OLED display (screen), show data from the respective sensors



If button A is pressed, show the word “red” on the screen, then change the colour of the neopixel strip (LED) red for 2s. Then, clear the pixels

If button B is pressed, show the word “blue” on the screen, then change the colour of the neopixel strip (LED) blue for 2s. Then, clear the pixels

If button A and B are pressed, show the word “purple” on the screen, then change the colour of the neopixel strip (LED) purple for 2s. Then, clear the pixels

Could change the threshold of **humidity** and **temperature** here

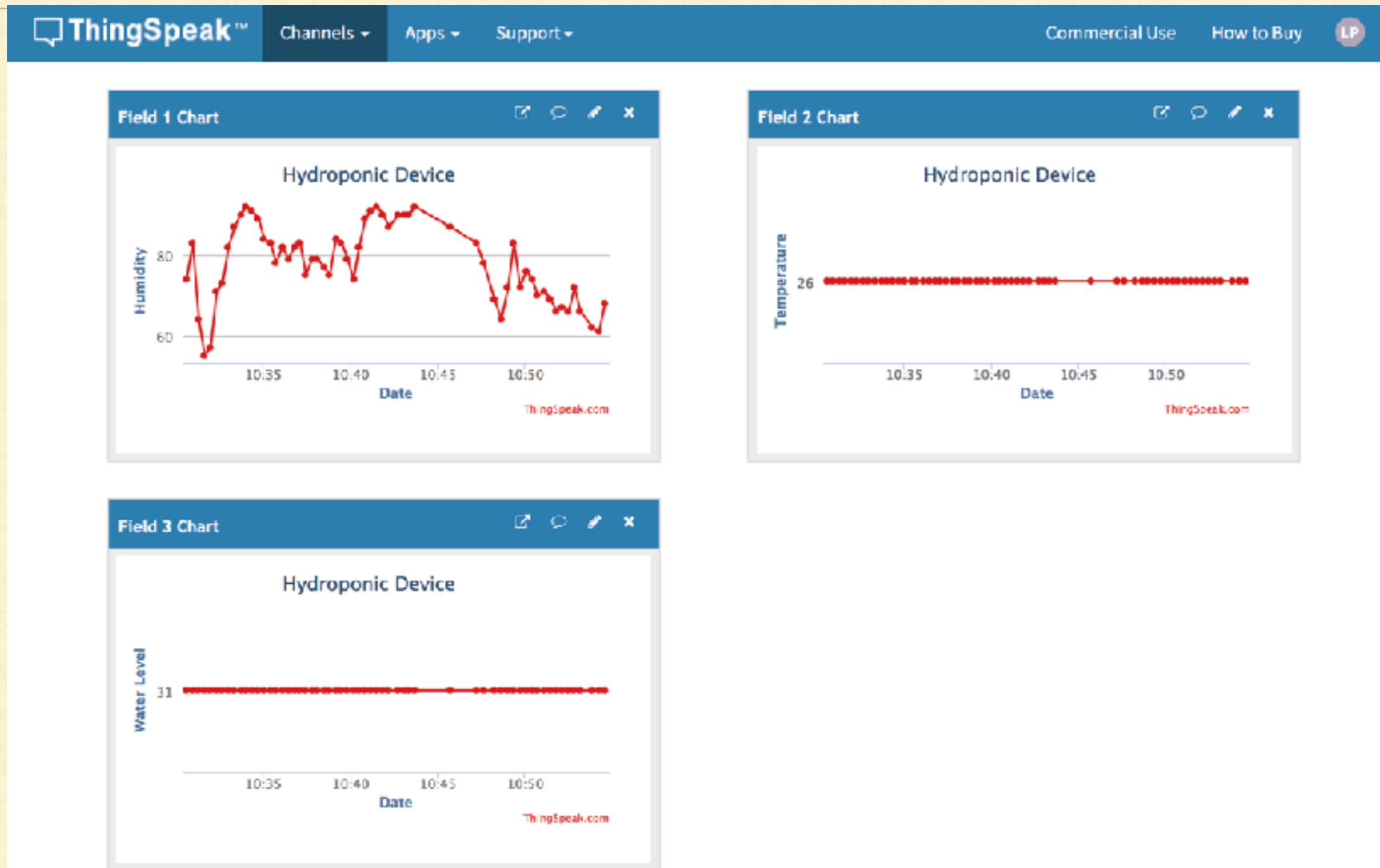
```
if (value of BME280 humidity(0~100) < 95) then
  digital write pin P2 to 1
  pause (ms) 2000
else
  digital write pin P2 to 0
if (value of BME280 temperature('C) > 28) then
  digital write pin P13 to 1
  digital write pin P15 to 0
  pause (ms) 2000
else
  digital write pin P13 to 0
  digital write pin P15 to 1
```

If humidity is less than **95%**, then turn on the humidifier

If temperature is greater than **28** degree Celsius, then turn on the cooler (P13)

If temperature is less than **28** degree Celsius, then turn on the heater (P15)

RESULTS



THINGSPEAK EMAIL TRIGGER

The screenshot shows the ThingSpeak interface for a channel named 'Hydroponic Device'. The top navigation bar includes 'Channels', 'Apps', and 'Support'. The 'Apps' dropdown menu is open, listing various applications: All Apps, MATLAB Analysis (highlighted), MATLAB Visualizations, Plugins, ThingTweet, TimeControl, React, TalkBack, and ThingHTTP. Below the channel header, there are sections for 'Import' and 'Export', each with a 'Time Zone' dropdown and a button ('Upload' or 'Download'). A 'Help' section is also visible on the right side of the page.

To trigger email responses, click on “MATLAB Analysis” here

Click **New** and choose a template to get started. Templates contain sample MATLAB® code for analyzing data.

New



Click here

Name	Created
Read Channel to Trigger Email 1	2020-05-13

Help

MATLAB Analysis

- Explore data collected in a channel or scraped from a website
- Find and remove bad data
- Convert data to different units
- Calculate new data
- Build data models

In your analysis code, you can also use functionality from any of the [MATLAB Toolboxes supported on ThingSpeak](#) that you are licensed to use. After analysis, you can write data to the channel or publish it to share your results.

[Learn More](#)

New to MATLAB?

- Watch [Getting Started with MATLAB](#) video tutorial.
- Learn interactively at [MATLAB Academy](#).

Templates:

- Custom (no starter code)
- Get data from a private channel
- Get data from a public channel
- Get data from a webpage

Examples: Sample code to analyze and transform data

- Calculate and display average humidity
- Calculate wind chill and update channel
- Remove outliers from wind speed data
- Convert temperature units
- Calculate high and low temperatures
- Read Channel to Trigger Email
- Replace missing values in data
- Analyze text for the most common color
- Read live web data for vessels at the port of Boston
- Scrape web temperature data

Create

Templates

MATLAB Analysis templates provide sample MATLAB code for analyzing data and writing it to a ThingSpeak channel. If you are new to MATLAB, you can learn interactively at [MATLAB Academy](#).

Examples

To see MATLAB Analysis in action, select the example and click Create.

These examples read data from public ThingSpeak channels:

- [Calculate and display average humidity](#) over the last 60 minutes, and write the results to a new channel.
- [Calculate wind chill and update channel](#) by writing to a new channel at regular intervals.
- [Remove outliers from wind speed data](#) over the past six hours, and write data to a new channel.
- [Convert temperature units](#) from Fahrenheit to Celsius, and write the results to a new channel.
- [Calculate high and low temperatures](#) over the past 24 hours, and write the data with timestamps to a new channel.
- [Trigger Email](#) by analyzing daily soil moisture values.
- [Replace missing values in data](#) of a weather channel, and clean the data using a list-wise deletion algorithm. Then display the missing values, or write data to a new channel.
- [Analyze text for the most common color](#) requested on the public Cheerlights channel, and write the data to a new channel.

These examples scrape data from websites:

- [Read live web data for vessels at the port of Boston](#) from the MarineTraffic website, count the number of vessels, and write the data to a new channel.
- [Scrape web temperature data](#) from the National Weather Service website, and write the data to a new channel.

Choose this template,
then click “Create”

My Profile

MathWorks Account Settings

MathWorks Account Email	lscstem@gmail.com
User ID	mwa0000018479603
Password	*****

Edit MathWorks Account Settings

Edit MathWorks Community Information

ThingSpeak Settings

Time Zone	LTC	Edit
User API Key	PVNMU6YPGV8W4EGJ	Refresh
MQTT API Key	<no API key>	Refresh
Alerts API Key	TAKDEF6CRTYRK7VV5	Refresh

Help

MathWorks Account Settings:

- MathWorks Account email and password are needed to sign in to ThingSpeak.
- User ID is displayed as the author of your public channels.
- If you edit your MathWorks Account settings, you will need to sign out of ThingSpeak and log back in.

ThingSpeak Settings:

- Time Zone is used when displaying data in your charts, and when scheduling your ThingSpeak apps.
- User API key is required to create and manage channels using the [REST API](#).
- MQTT API key is required to subscribe to channel topics using the [MQTT API](#).

API Requests

Get Channel List

```
GET https://api.thingSpeak.com/channels.json?api_key=PVNMU6YPGV8W4EGJ
```

Create a Channel

```
POST https://api.thingSpeak.com/channels.json
api_key=PVNMU6YPGV8W4EGJ
name=My New Channel
```

Clear a Channel Feed

```
DELETE https://api.thingSpeak.com/channels/CHANNEL_ID/feeds.json
api_key=PVNMU6YPGV8W4EGJ
```

Delete a Channel

```
DELETE https://api.thingSpeak.com/channels/CHANNEL_ID
api_key=PVNMU6YPGV8W4EGJ
```

Update Channel Metadata

```
PUT https://api.thingSpeak.com/channels.json
api_key=PVNMU6YPGV8W4EGJ
name=Changed Channel Name
```

[Learn More](#)

Copy your alertApiKey here



Name

Read Channel to Trigger Email 1

My Channels

Documentation

New Channel

Channel Info

Name: Hydroponic Device

Channel ID: 1059063

Access: Public

Read API Key: JK3QD18MPNGCKHL

Write API Key: 45GTR0617ZYPTFFL

Fields:

- 1: Humidity
- 2: Temperature
- 3: Water Level

Copy your channel ID here

MATLAB Code

```

1 % Read the soil moisture channel data from the past two weeks.
2 % Send an email and tell the user to add water if the value
3 % is in the lowest 10 %.
4
5 % Store the channel ID of the moisture sensor channel.
6 channelID = 1059063;
7
8 % Provide the ThingSpeak alerts API key. All alerts API keys start with TAK.
9 alertApiKey = 'TAK0EFGCRTYRK7VV5';
10
11 % Set the address for the HTTP call.
12 alertUrl="https://api.thingspeak.com/alerts/send";
13
14 % webwrite uses weboptions to add required headers. Alerts needs a ThingSpeak-Alerts-API-Key header.
15 options = weboptions("HeaderFields", ["ThingSpeak-Alerts-API-Key", alertApiKey]);
16
17 % Set the email subject.
18 alertSubject = sprintf("Plant soil information");
19
20 % Read the recent data.
21 moistureData = thingSpeakRead(channelID,'NumDays',30,'Fields',1);
22
23 % Check to make sure the data was read correctly from the channel.
24 if isempty(moistureData)
25     alertBody = ' No data read from plant. ';
26 else
27     % Calculate a 10% threshold value based on recent data.
28     span = max(moistureData) - min(moistureData);
29     dryValue = 0.1 * span + min(moistureData);
30
31     % Get the most recent point in the array of moisture data.
32     lastValue = moistureData(end);
33
34     % Set the outgoing message
35     if (lastValue <= dryValue)
36         alertBody = ' No water Needed. ';
37     elseif (lastValue > dryValue)
38         alertBody = ' I need water! ';
39     end
40 end
41
42 % Catch errors so the MATLAB code does not disable a TimeControl if it fails
43 try
44     webwrite(alertUrl, "body", alertBody, "subject", alertSubject, options);
45 catch someException
46     fprintf("Failed to send alert: %s\n", someException.message);
47 end
48
    
```

Paste your alertApiKey here

These words will be shown on your email, you could change your messages here

Suggest NOT to send more than 2 messages per hour, could cause error

Save and Run

Save

Clear Output

Schedule Actions

Notify me via email if this MATLAB Analysis fails when triggered by TimeControl or React.

 TimeControl

Name	Recurrence	Last Ran	Run At
<input checked="" type="checkbox"/> New TimeControl	Every 1 hour(s)	2020-05-18 3:33 am	2020-05-18 4:33 am

 React

Name	Test Frequency
<input checked="" type="checkbox"/> React 2	On Data Insertion

Create new react here



Delete MATLAB Code?

Delete

[Apps](#) / [React](#) / [React2](#) / [Edit](#)

React Name

React 2

Condition
Type

Numeric ▾

Test
Frequency

On Data Insertion ▾

Condition

If channel

Hydroponic Device (1059063) ▾

field

3 (Water Level) ▾

is greater than or equal to ▾

50

Action

MATLAB Analysis ▾

Code to execute

Read Channel to Trigger Email 1 ▾

Options

 Run action only the first time the condition is met Run action each time condition is met[Save React](#)

Want to delete this React?

[Delete React](#)

Help

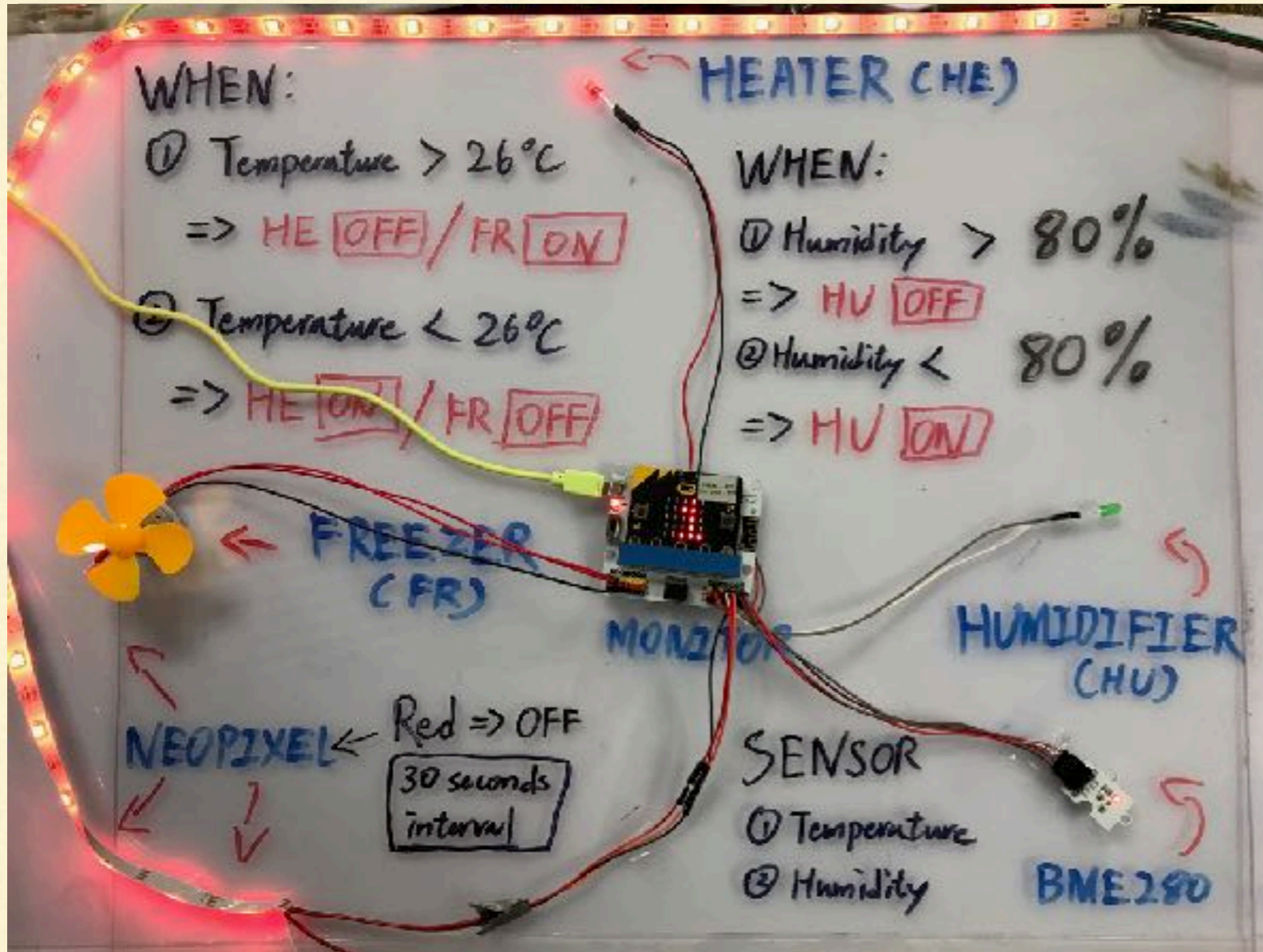
React Settings

- **React Name:** Enter a unique name for your React.
- **Condition Type:** Select a condition type corresponding with your data. A channel can hold numeric sensor data, text, strings, status updates, or geographic location information.
- **Test Frequency:** Choose whether to test your condition every time data enters the channel or on a periodic basis.
- **Condition:** Select a channel, a field and the condition for your React.
- **Action:** Select ThingTweet, ThingHTTP, or MATLAB Analysis to run when the condition is met.
- **Options:** Select when the React runs.

[Learn More](#)

In class, it's impossible for all students to try out their codes on the hydroponic device. Here are some of the possible investigations students could do...

SIMPLIFIED MODEL OF HYDROPONIC DEVICE



Simulator Code: https://makecode.microbit.org/_5L76yM6Ju9Hc

SIMPLIFIED VERSION HYDROPONIC DEVICE CODE

The image shows a Scratch code editor with the following blocks:

- on start** (blue block)
- set strip2 to NeoPixel at pin P16 with 50 leds as RGB (GRB format)** (teal block, highlighted with a red border)
- set year 2020** (red block)
- month 5** (red block)
- day 22** (red block)
- weekday 3** (red block)
- hour 14** (red block)
- minute 0** (red block)
- second 0** (red block)

SIMPLIFIED VERSION HYDROPONIC DEVICE CODE

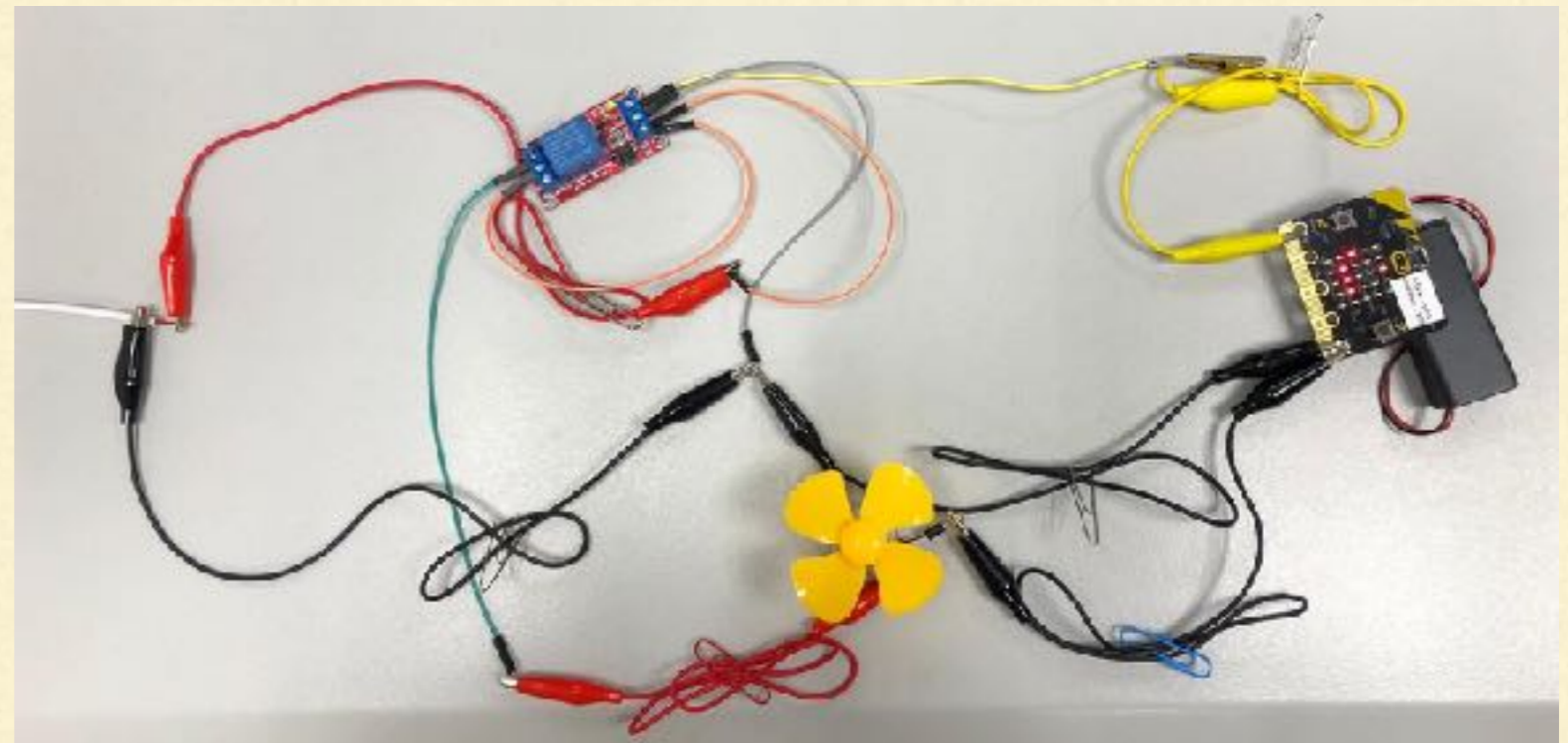
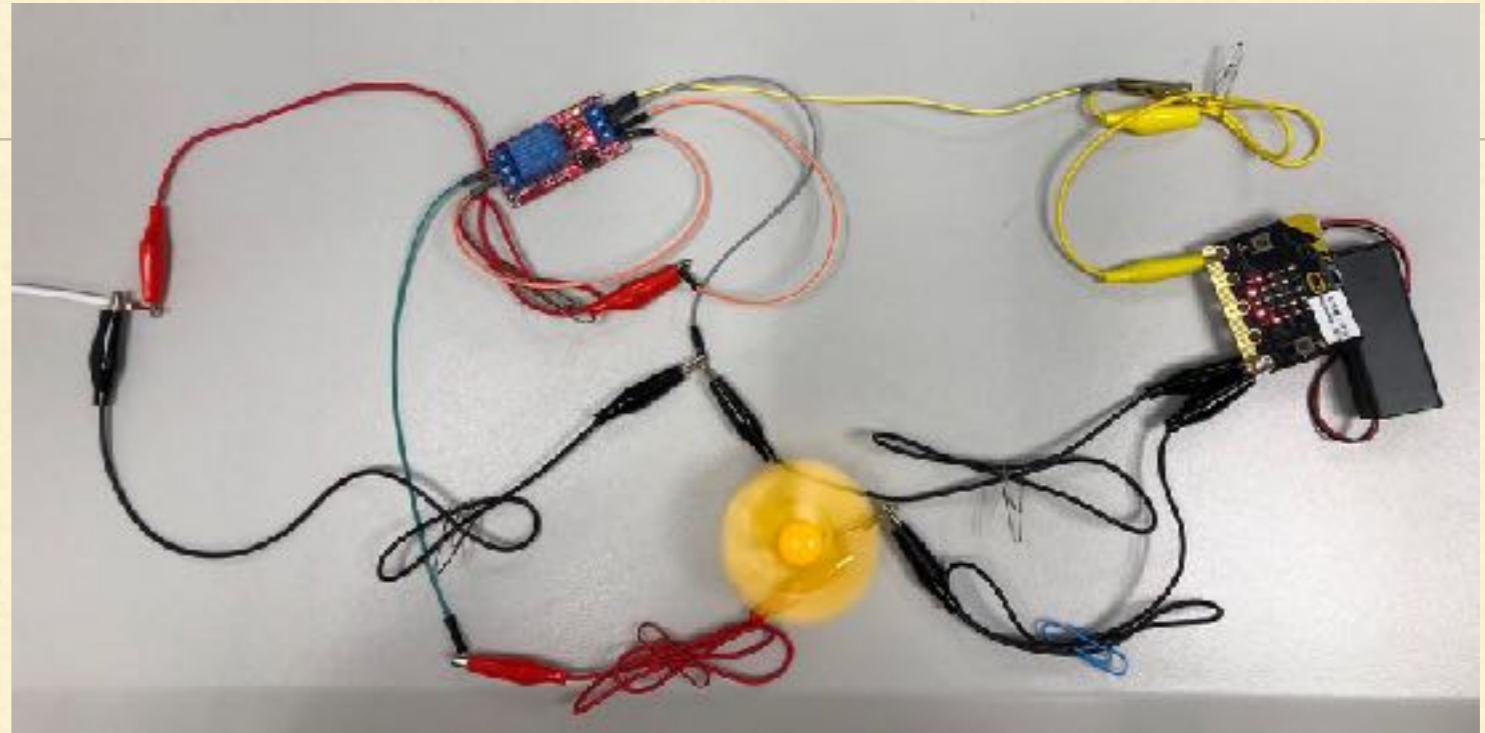
```
forever loop containing:  
  join block with dropdowns: Hour, Minute, Second, and separator ":"  
  show string block with input: ":"  
  show string block with input: "T"  
  show number block with input: value of BME280 temperature('C')  
  show string block with input: "H"  
  show number block with input: value of BME280 humidity(0~100)
```

The image shows a Scratch code block for a 'forever' loop. Inside the loop, there are several blocks: a 'join' block with dropdown menus for 'Hour', 'Minute', and 'Second', and a separator ':'; a 'show string' block with the input ':'; a 'show string' block with the input 'T'; a 'show number' block with the input 'value of BME280 temperature('C)'; a 'show string' block with the input 'H'; and a 'show number' block with the input 'value of BME280 humidity(0~100)'. The background is a light blue grid.

SIMPLIFIED VERSION HYDROPONIC DEVICE CODE

```
if value of BME280 temperature(°C) <= 25 then
  digital write pin P1 to 0
  digital write pin P2 to 0
  digital write pin P13 to 1
  pause (ms) 100
else
  digital write pin P1 to 1
  digital write pin P2 to 1
  digital write pin P13 to 0
  pause (ms) 100
+
if value of BME280 humidity(0-100) <= 80 then
  digital write pin P15 to 1
  pause (ms) 100
else
  digital write pin P15 to 0
  pause (ms) 100
+
if 30 >= Second then
  strip2 show color red
  strip2 show
else
  strip2 show color black
  strip2 show
+
```

CHECK WHETHER RELAY WORKS OR NOT

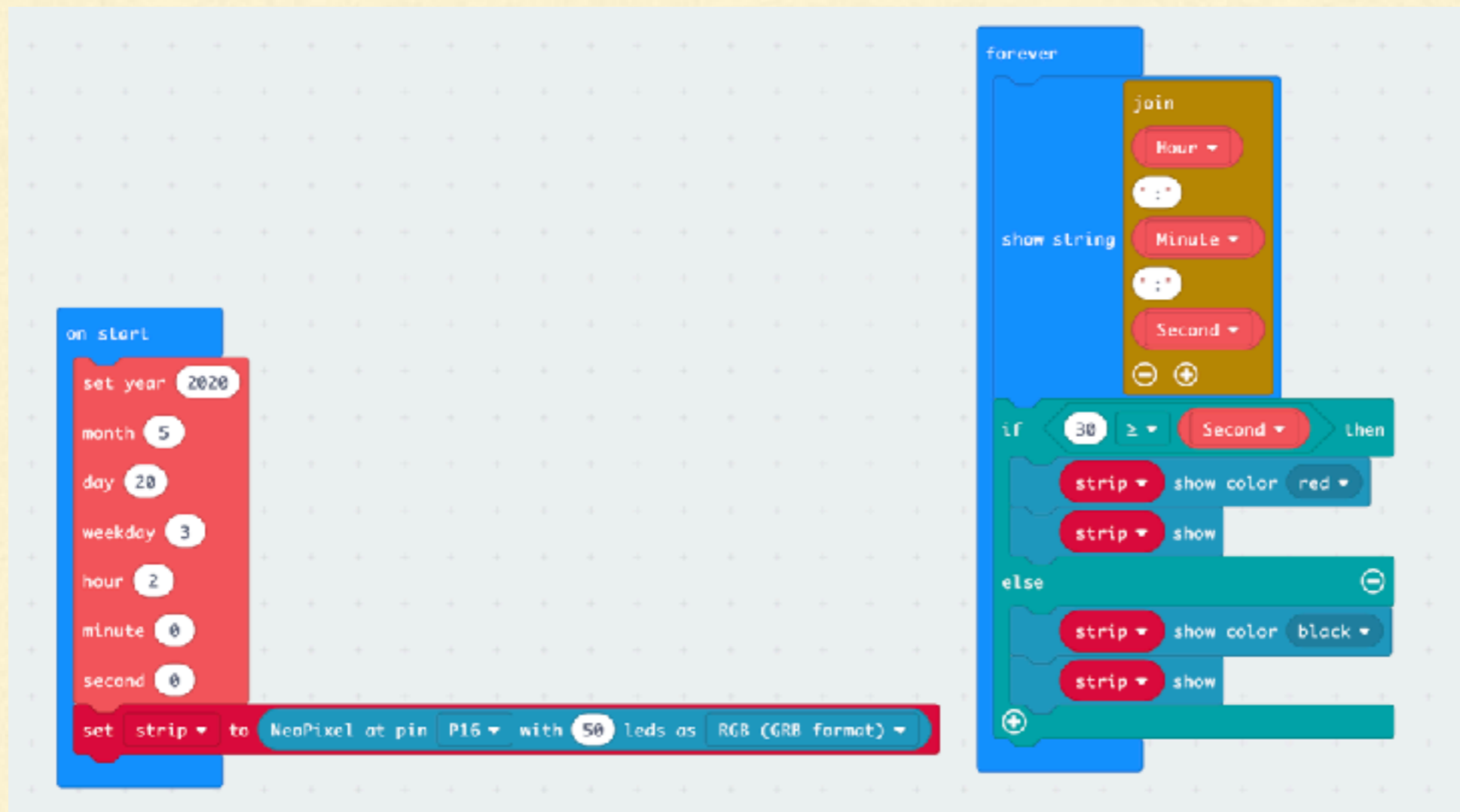


```
on button A pressed
  show icon [LED OFF]
  digital write pin P0 to 1

on button B pressed
  show icon [LED ON]
  digital write pin P0 to 0
```

OTHER POSSIBILITIES

- Light dark cycle



The image shows a Scratch code editor with two scripts. The first script, 'on start', sets the year to 2020, month to 5, day to 20, weekday to 3, hour to 2, minute to 0, and second to 0. It then sets a NeoPixel strip at pin P16 with 50 LEDs in RGB (GRB format). The second script, 'forever', joins the hour, minute, and second into a string and shows it. It then checks if the second is greater than or equal to 30. If true, it shows the color red; otherwise, it shows the color black.

```
on start
  set year to 2020
  month 5
  day 20
  weekday 3
  hour 2
  minute 0
  second 0
  set strip to NeoPixel at pin P16 with 50 leds as RGB (GRB format)

forever
  join
    Hour
    Minute
    Second
  show string
  if 30 >= Second then
    strip show color red
    strip show
  else
    strip show color black
    strip show
```

https://makecode.microbit.org/_IFmKjTcwJIYK

REFERENCES

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 - <https://www.grobo.io/blogs/growing/how-different-colors-of-light-affect-plant-growth>
 - <https://www.greenhousetoday.com/does-the-color-of-light-affect-plant-growth/>
 - <https://www.gardeningknowhow.com/garden-how-to/design/lighting/red-light-vs-blue-light.htm>
 - <https://www.canr.msu.edu/uploads/resources/pdfs/red-light.pdf>
-