

# IoT Product Design and Coding Bootcamp

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- Particle Argon Pin Layout

# IoT Fun



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# Brian Rashap, Ph.D.

- Proud husband of Krista and father of Shelby (21) and Ethan (18)
- Electrical Engineer with 25 years industrial experience
- High School track coach
- Hobbies: running, cycling, reading, spending time with family



# Introductions

## INTRODUCTIONS

# Class Rules

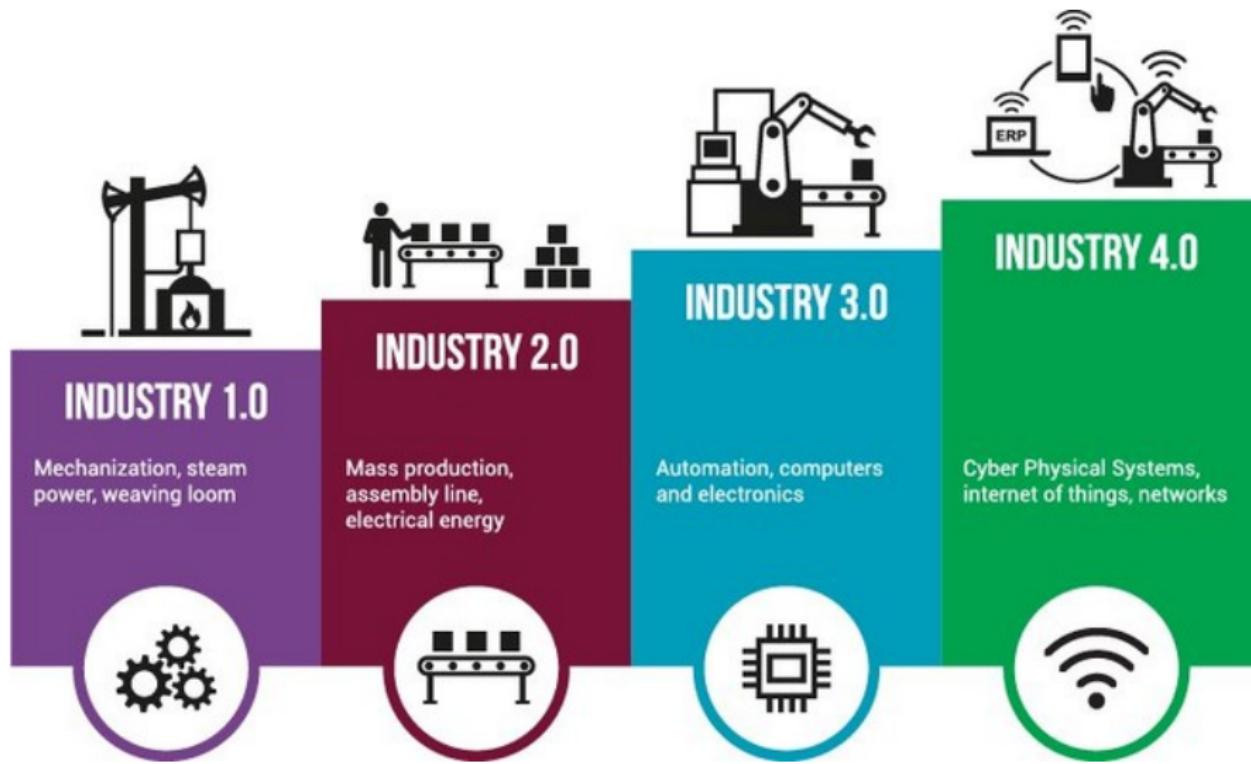
- Respect Each Other, Help Each Other
- Ask Questions
- Be On Time (let's us know via Slack if you won't be here)
- Keep Your Workspace and the Classroom Neat and Tidy
- If you are struggling, let myself, Susan, or Esteban know. We are here to HELP!

# Grading

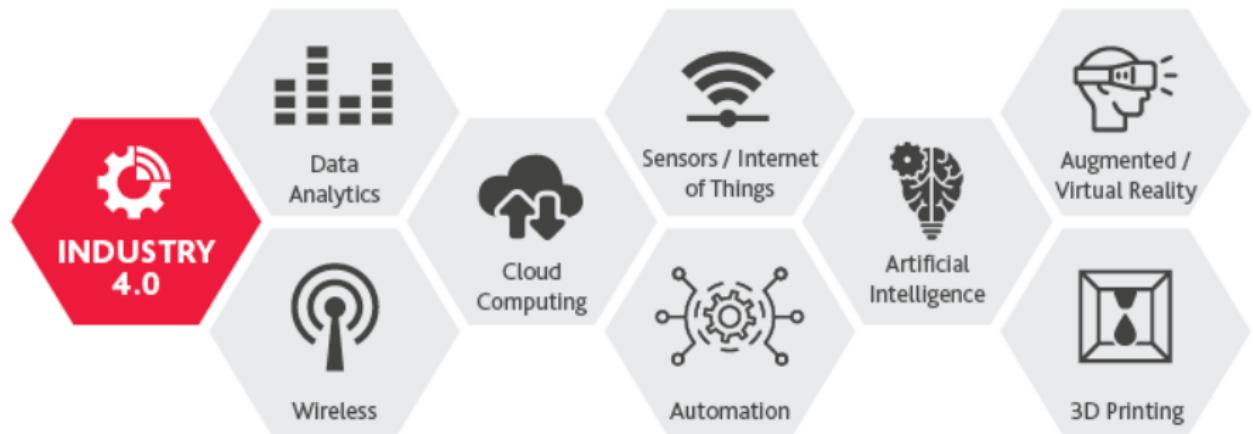
- ① In class assignments - 30
- ② Individual smart device 20
- ③ Capstone 40
- ④ Assessments 10

More information later today on how assignments are turned in

# Evolution of Industry

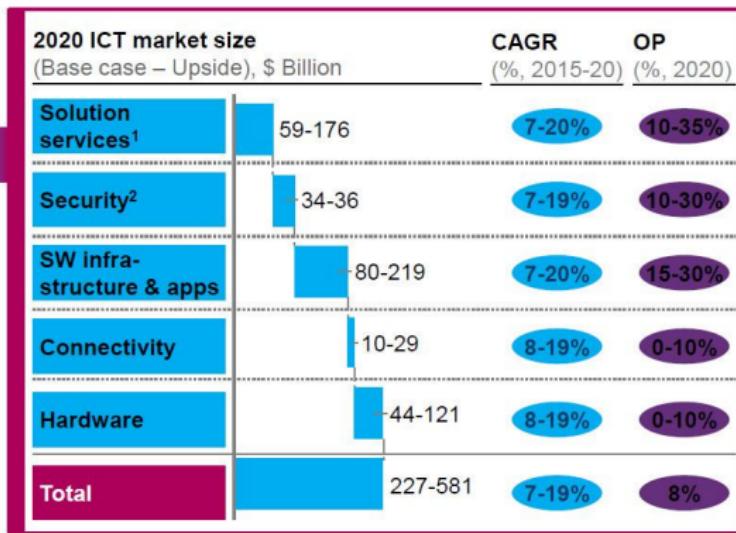
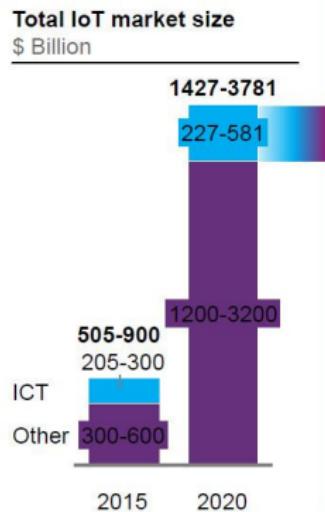


# Components of Industry 4.0



# IoT Market Size

Resulting in a large IoT market size, of which a significant component is ICT

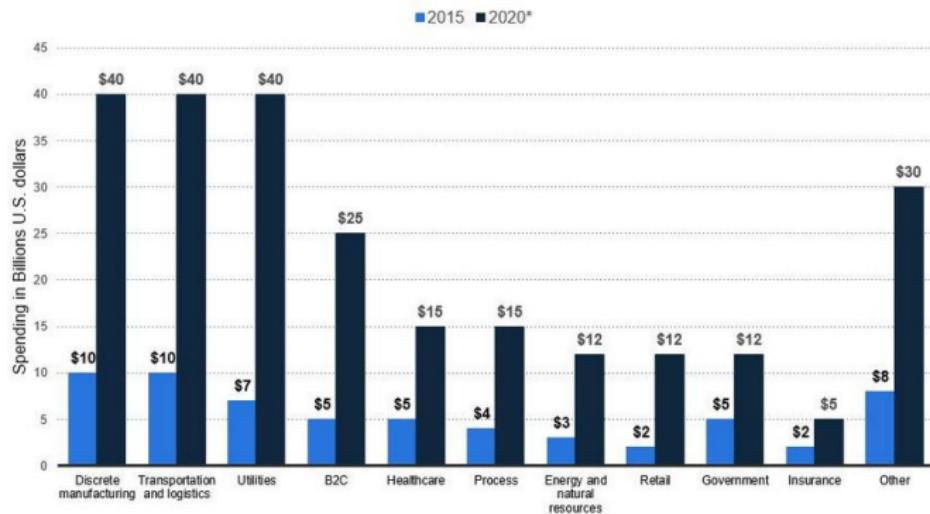


<sup>1</sup> Solution services not considered technical products

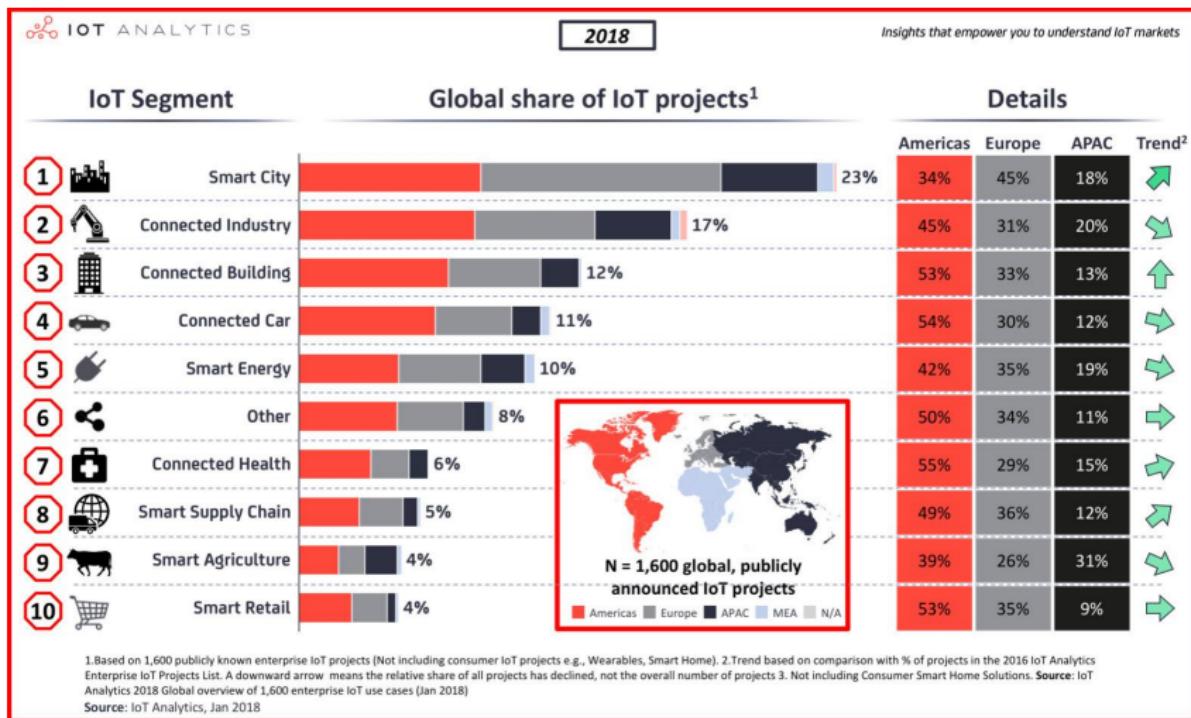
<sup>2</sup> \$3-\$6B is IoT security and \$25-\$35B is for mobile security

# Spending by IoT Vertical

**Spending on Internet of Things Worldwide by Vertical in 2015 and 2020  
(in billions of U.S. dollars)**



# IoT Segments

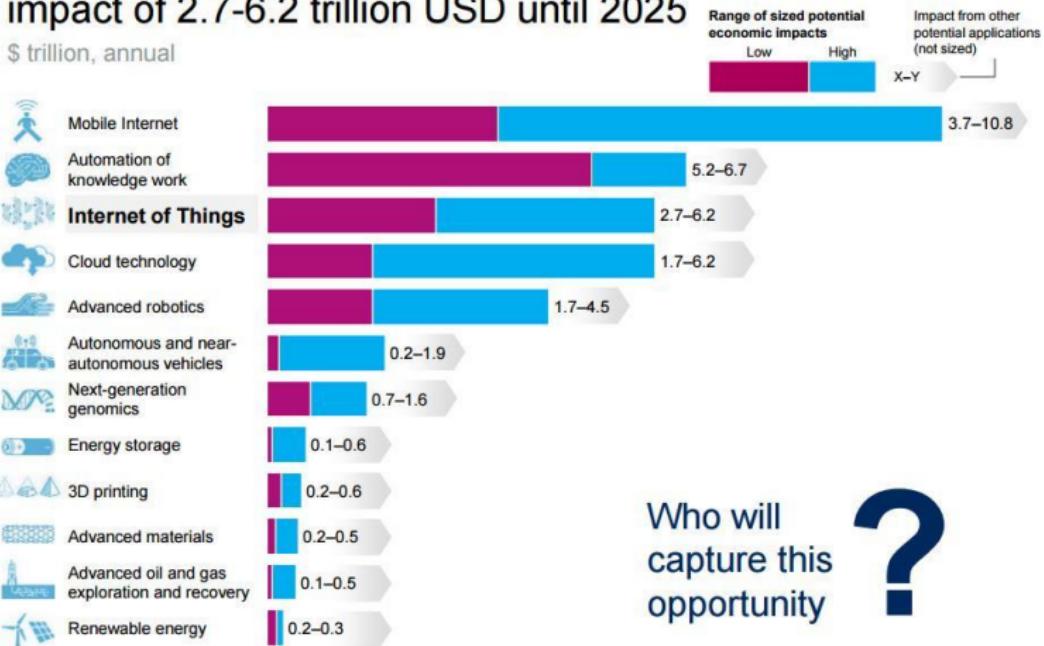


# IoT Potential Economic Impact

## THE IoT PLATFORM OPPORTUNITY

The Internet of Things (IoT) has a potential economic impact of 2.7-6.2 trillion USD until 2025

\$ trillion, annual



Who will capture this opportunity?



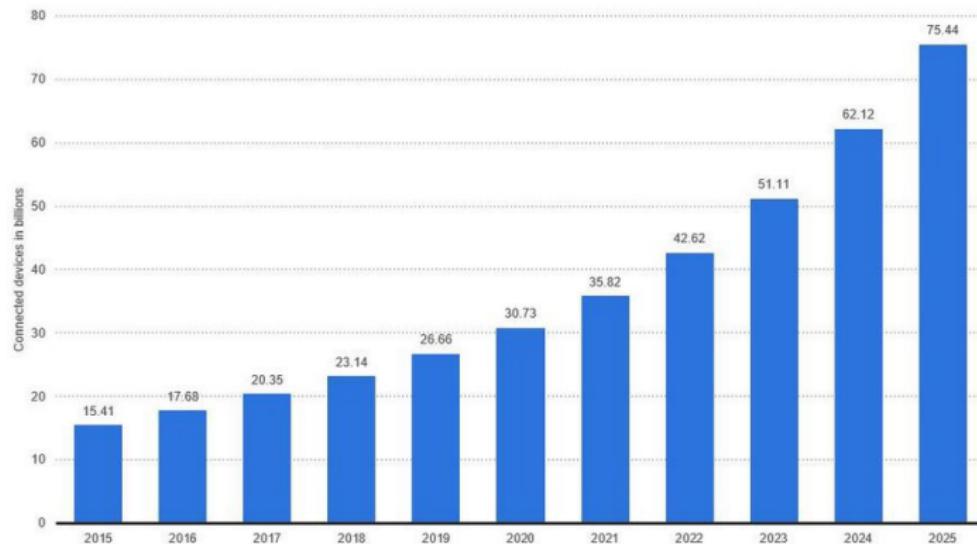
SOURCE: McKinsey Global Institute analysis

McKinsey & Company 3

# IoT Growth

Internet of Things - number of connected devices worldwide 2015-2025

## Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions)

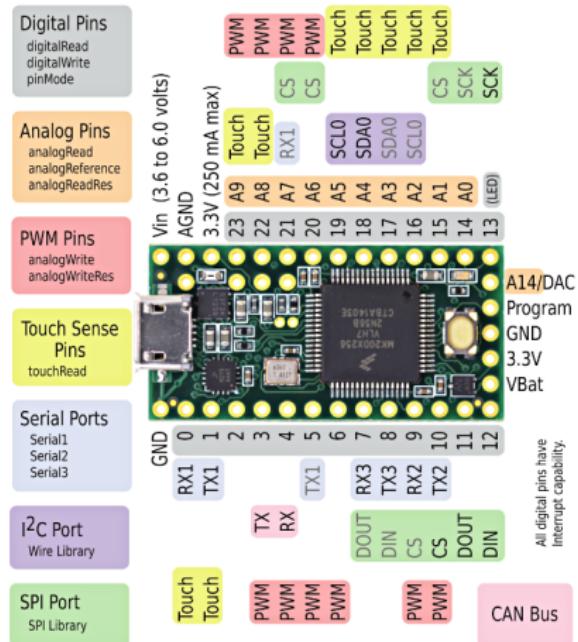


# Our First Microcontroller



# Teensy 3.2

- Cortex-M4 72MHz (overclocked to 96 MHz)
- 34 GPIO pins
- 3.3V and 5.0V operating voltages
- 500mA of available power with USB



# Arduino IDE for Teensy

We are going to start off using the Arduino IDE<sup>1</sup>. The Arduino IDE is programmed essentially using C++ code, but make the compiling and loading onto the microcontroller simpler.

We begin by installing the Arduino IDE:

*<https://www.arduino.cc/en/main/software>*

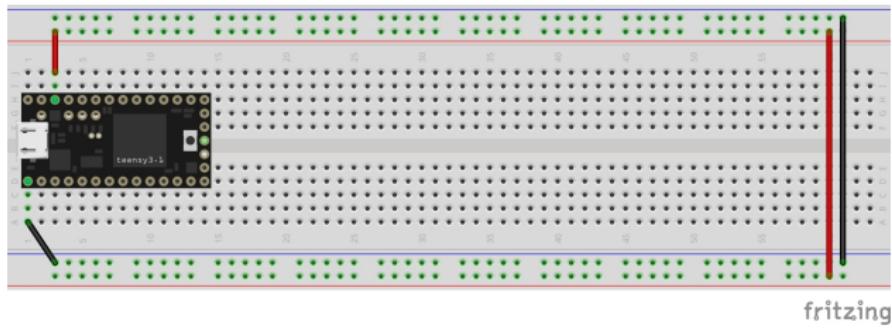
Then, we install the Teensyduino add-on:

*[https://www.pjrc.com/teensy/td\\_download.html](https://www.pjrc.com/teensy/td_download.html)*

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<sup>1</sup>An IDE, or Integrated Development Environment, enables programmers to consolidate the different aspects of writing a computer program.

# Teensy on Breadboard

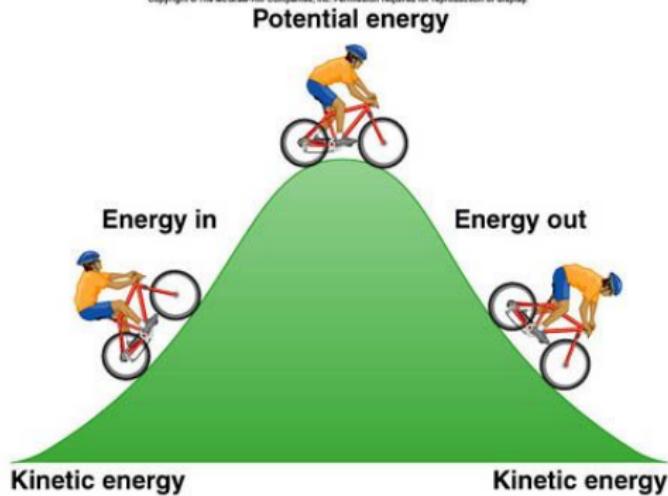


# Basic Structure of Arduino Sketch

```
1 // heading is used to document and include
2 packages. It is also used to configure the
3 coding environment.
4
5 void setup() {
6     // put your setup code here, to run once:
7 }
8
9 void loop() {
10    // put your main code here, to run repeatedly:
11 }
12 }
```

# Energy

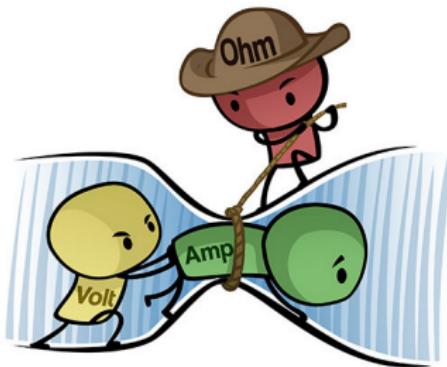
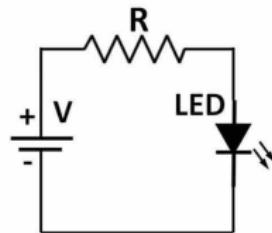
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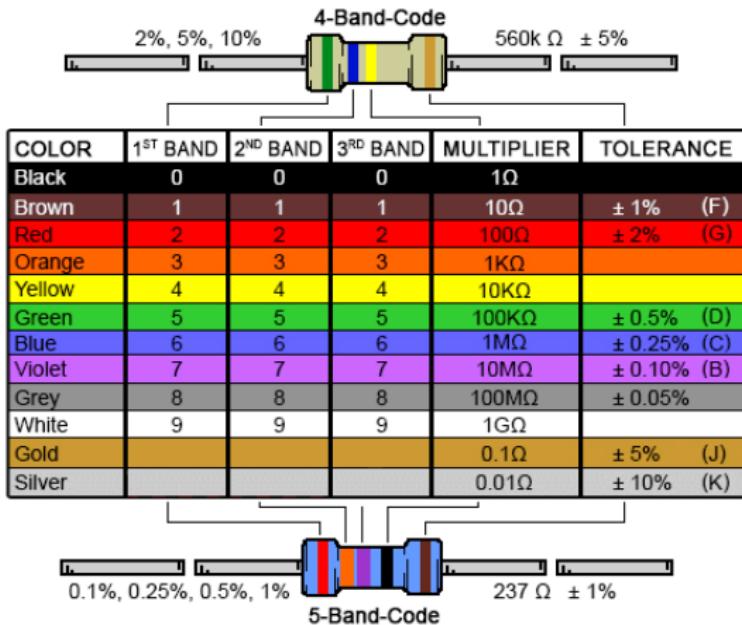
# Ohm's Law

## Ohm's Law

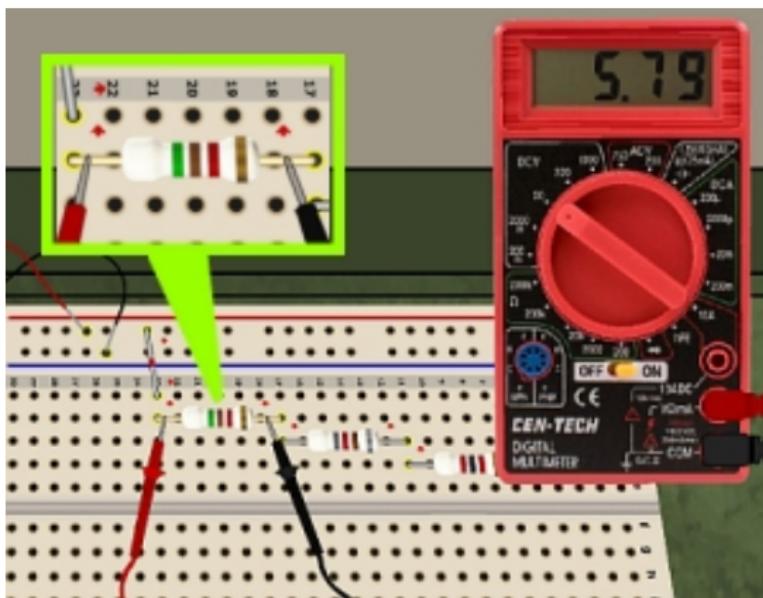
$$V = I * R$$



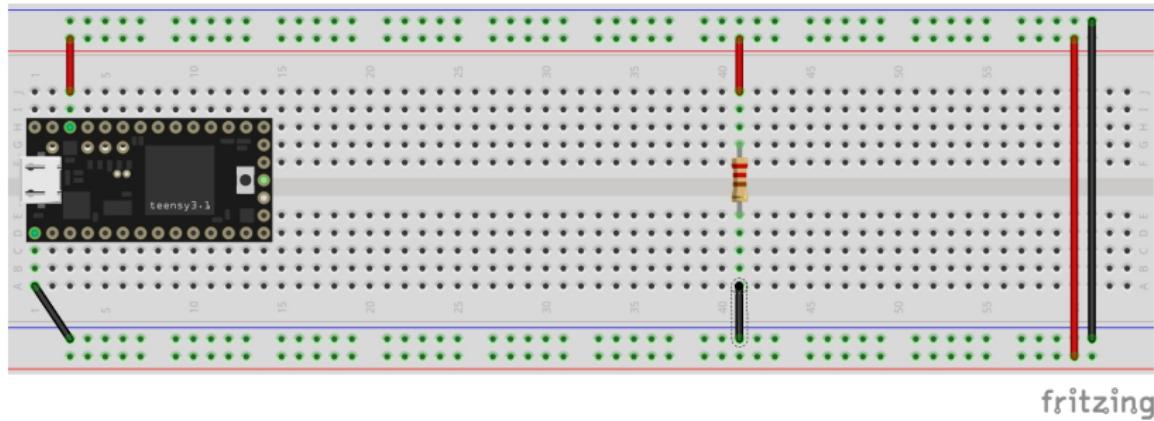
# Resistor Color Bands



# Measuring Voltage, Current, and Resistance

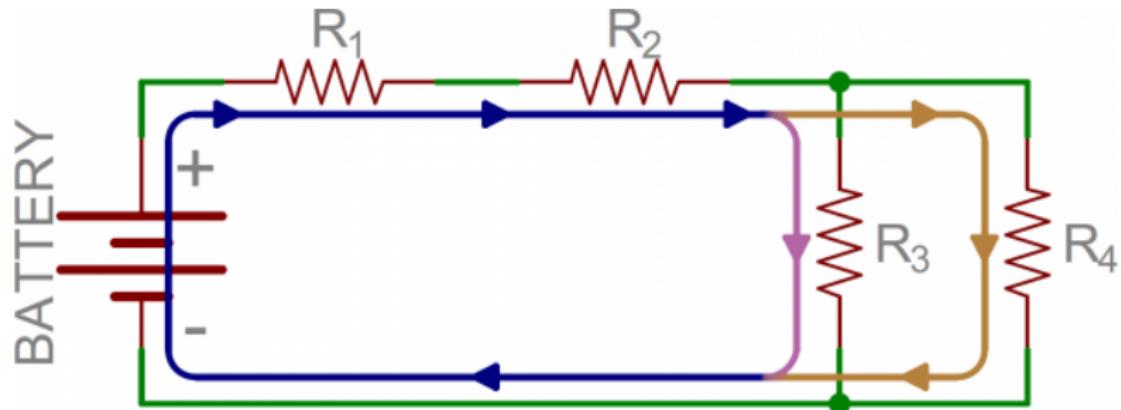


# One Resistor

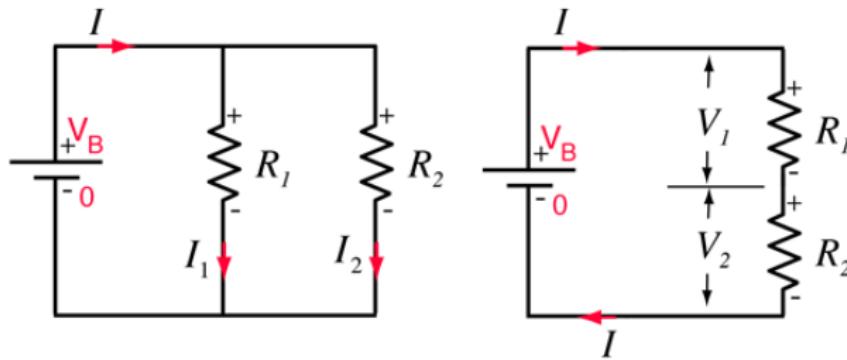


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# Resistors in Series and Parallel



# Resistors in Series and Parallel



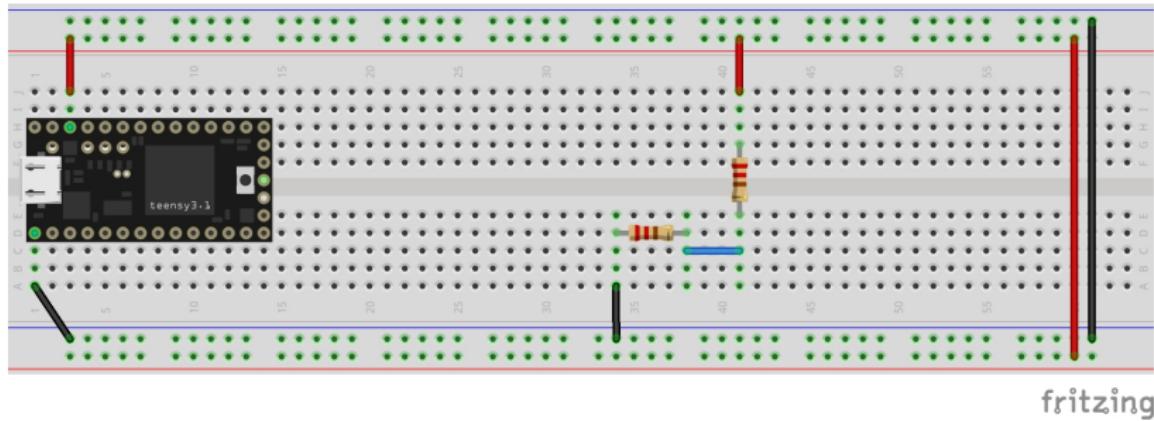
Parallel resistors

$$\frac{1}{R_{\text{equivalent}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

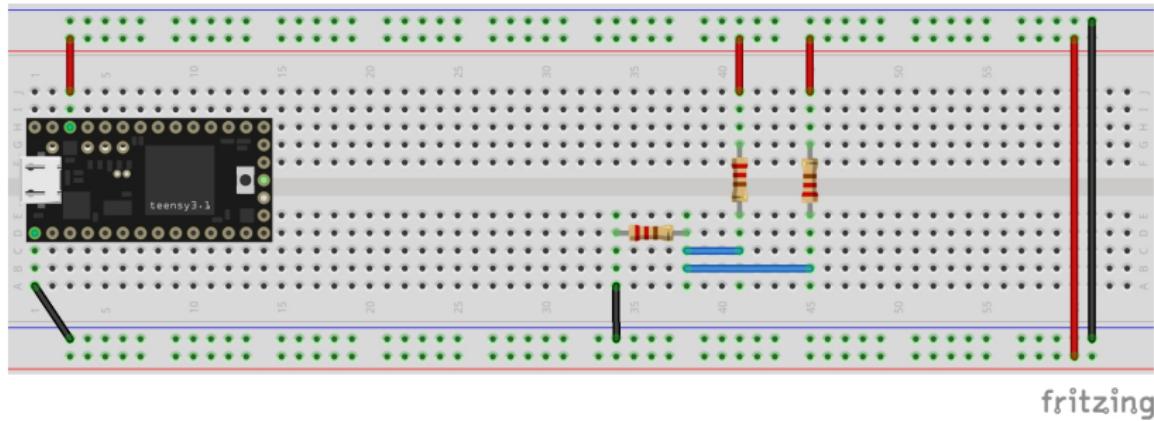
Series resistors

$$R_{\text{equivalent}} = R_1 + R_2$$

## Resistors in Series



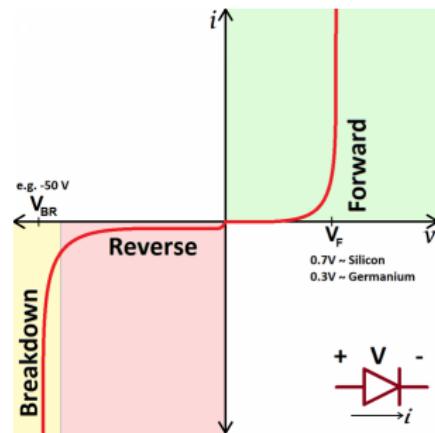
# Resistors in Series and Parallel



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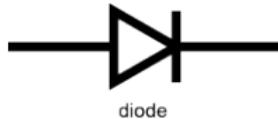
# Diodes

The key function of a diode is to control the direction of current-flow. Current passing through a diode can only go in one direction, called the forward direction. Current trying to flow the reverse direction is blocked.



# Light Emitting Diodes

LEDs (that's "ell-ee-dees") are a particular type of diode that convert electrical energy into light.



diode



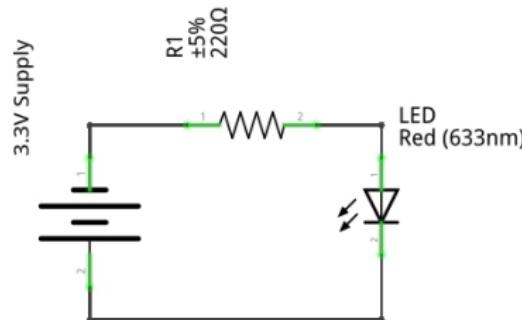
light emitting diode

# Current Limiting Resistors

As a LED has very little resistance, when it is connected directly to a power supply, the current draw will exceed its specs and it will burn out.

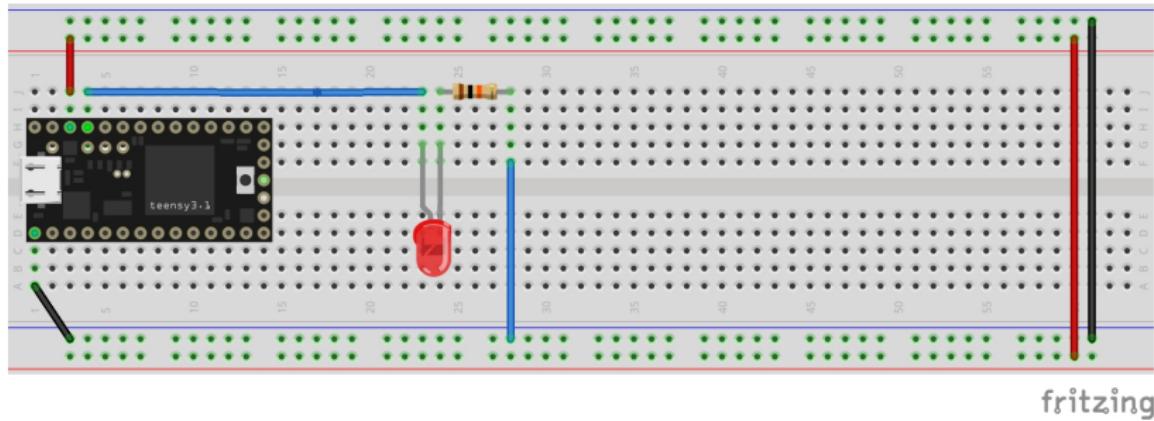
$$V_{pp} - V_{LED} = IR \implies R \geq \frac{V_{pp} - V_{LED}}{I_{max}}$$

For a 3.3V power supply, a 0.43V across the LED, and a max current of 100mA, the resistor needs to be greater than  $29\Omega$ .



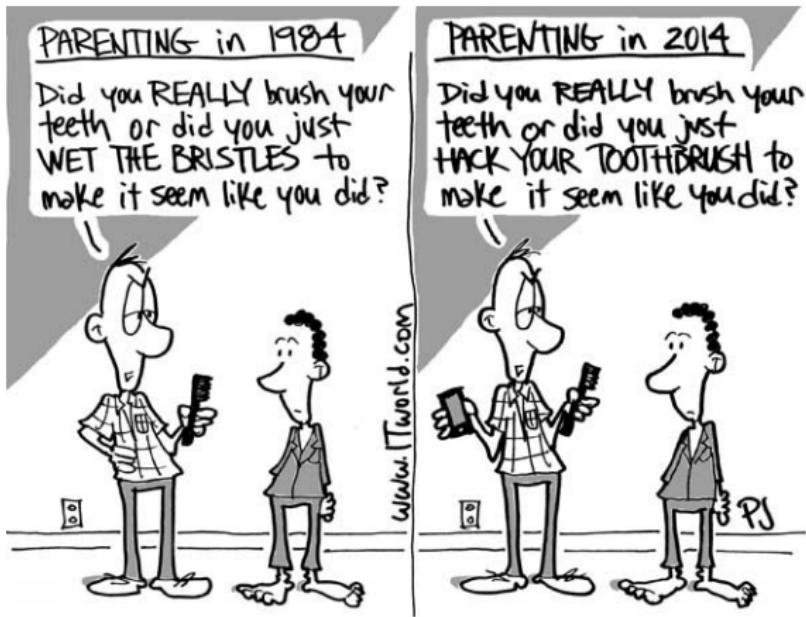
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# Hello LED



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# IoT Fun



# REVIEW: For Loops

```
1 // FOR loop syntax
2 for (initialization; condition; increment) {
3     // statement(s);
4 }
5
6 // EXAMPLE
7 for (i=0, i <= 255, i=i+5) {
8     analogWrite(ledPin, i);
9 }
```

# While loops

```
1 // WHILE loop syntax
2 while (condition) {
3     // statement(s)
4 }
5
6
7 // EXAMPLE
8 while (button == HIGH) {
9     digitalWrite(ledPin, HIGH);
10 } //continue this loop until button is released
```

# For vs While Loops

## For VS While Loop

Comparison Chart

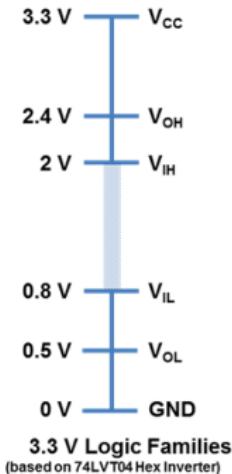
For Loop	While Loop
The for loop is used for definite loops when the number of iterations is known.	The while loop is used when the number of iterations is not known.
For loops can have their counter variables declared in the declaration itself.	There is no built-in loop control variable with a while loop.
This is preferable when we know exactly how many times the loop will be repeated.	The while loop will continue to run infinite number of times until the condition is met.
The loop iterates infinite number of times if the condition is not specified.	If the condition is not specified, it shows a compilation error.

# Serial Monitor

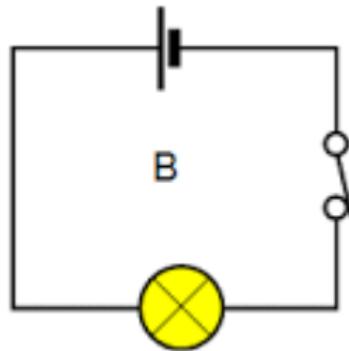
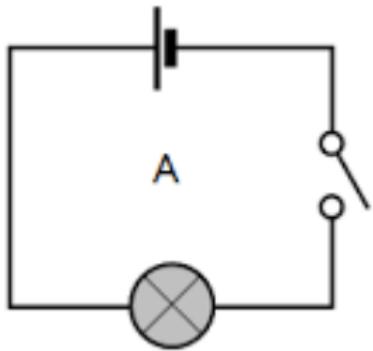
```
1 void setup() {  
2  
3 // Enable Serial Monitor  
4 Serial.begin (9600);  
5 while (!Serial); // wait for Serial monitor  
6 Serial.println ("Ready to Go");  
7 }  
8  
9 void loop() {  
10 for (i=0; i <=13; i++)  
11 Serial.print(i);  
12 delay(ledDelay);  
13 }
```

# Digital Output

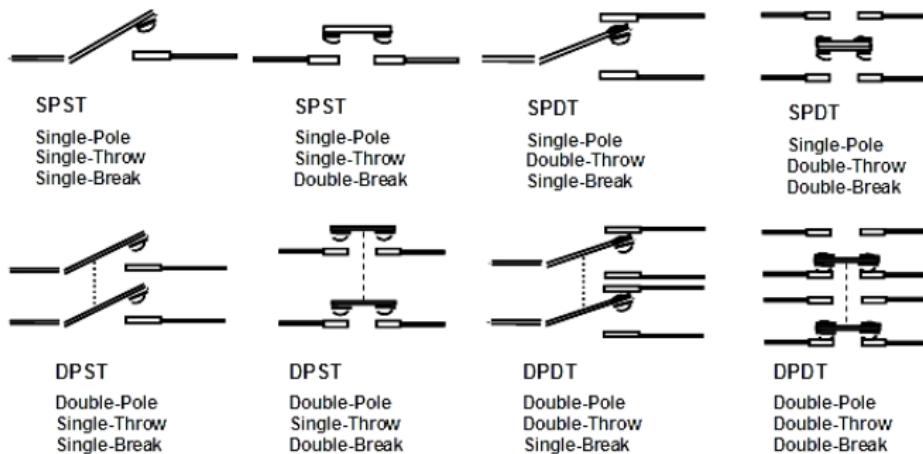
Digital electronics rely on binary logic to store, process, and transmit data or information. Binary Logic refers to one of two states – ON or OFF. This is commonly translated as a binary 1 or binary 0. A binary 1 is also referred to as a HIGH signal and a binary 0 is referred to as a LOW signal.



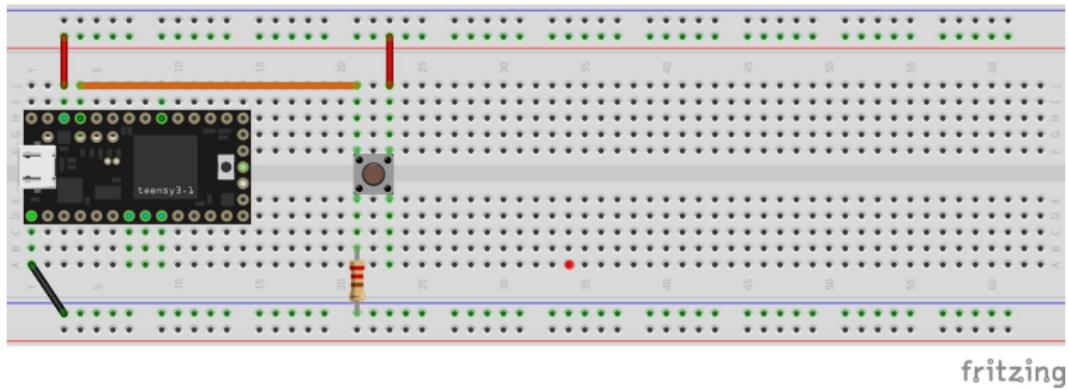
# Switches



# Types of Switches



# Our First Button

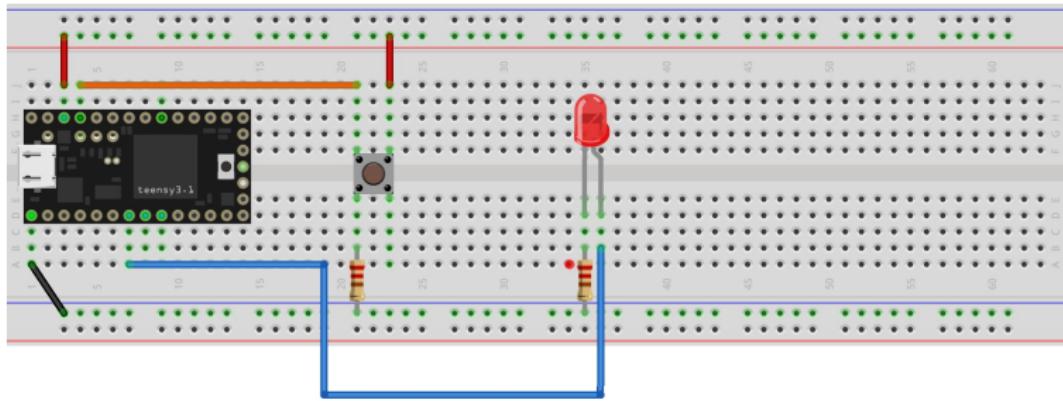


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# If Statements

```
1 // IF statement SYNTAX
2 if (condition) {
3     //statement(s)
4 }
5
6 // EXAMPLE
7 if (button == HIGH) {
8     digitalWrite(ledPin, HIGH);
9 }
```

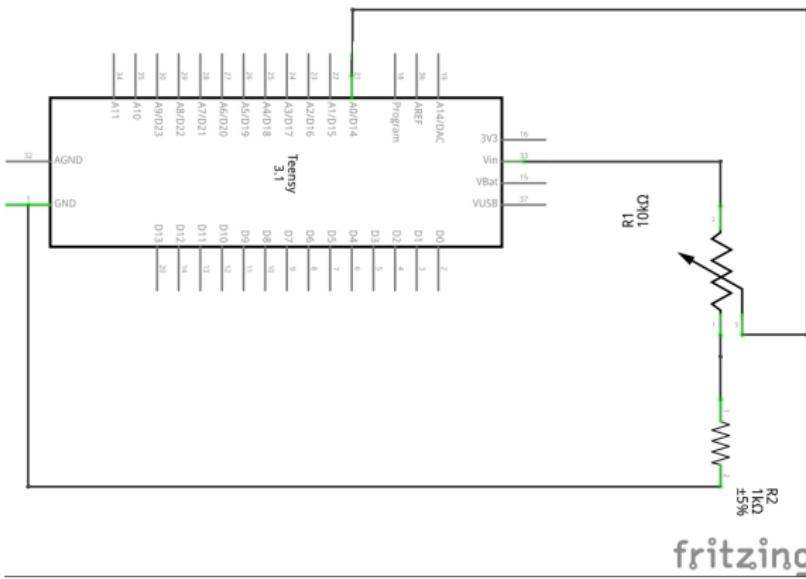
# Button and LED



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# Analog Input Schematic

Teensy 3.1



# Anatomy of a Function

## Anatomy of a C function

Datatype of data returned,  
any C datatype.

"void" if nothing is returned.

Parameters passed to  
function, any C datatype.

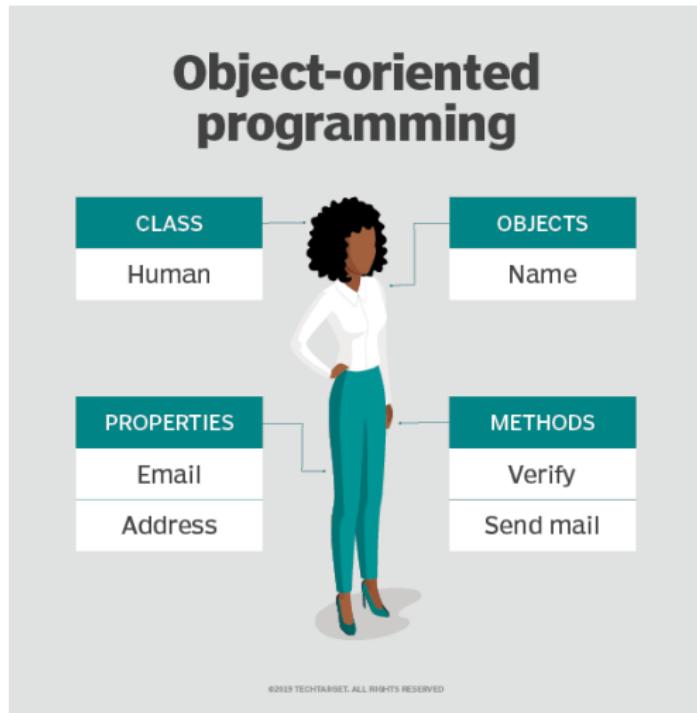
```
int myMultiplyFunction(int x, int y){  
    int result;  
    result = x * y;  
    return result;  
}
```

Function name

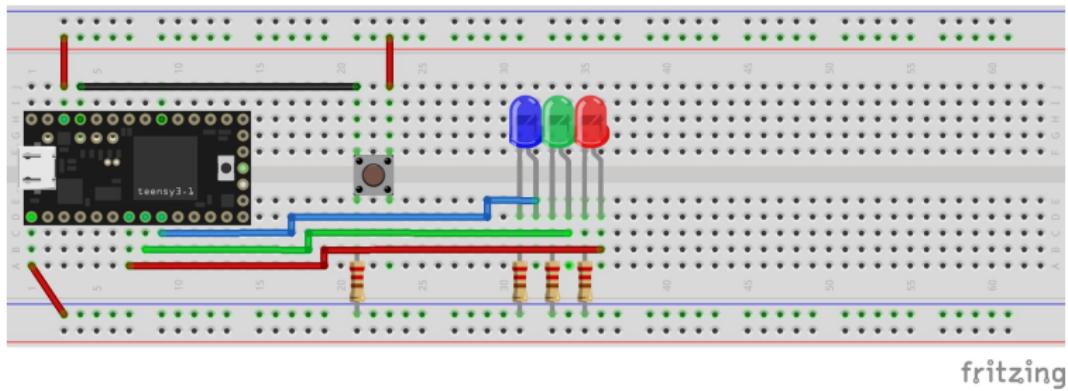
Return statement,  
datatype matches  
declaration.

Curly braces required.

# Objects

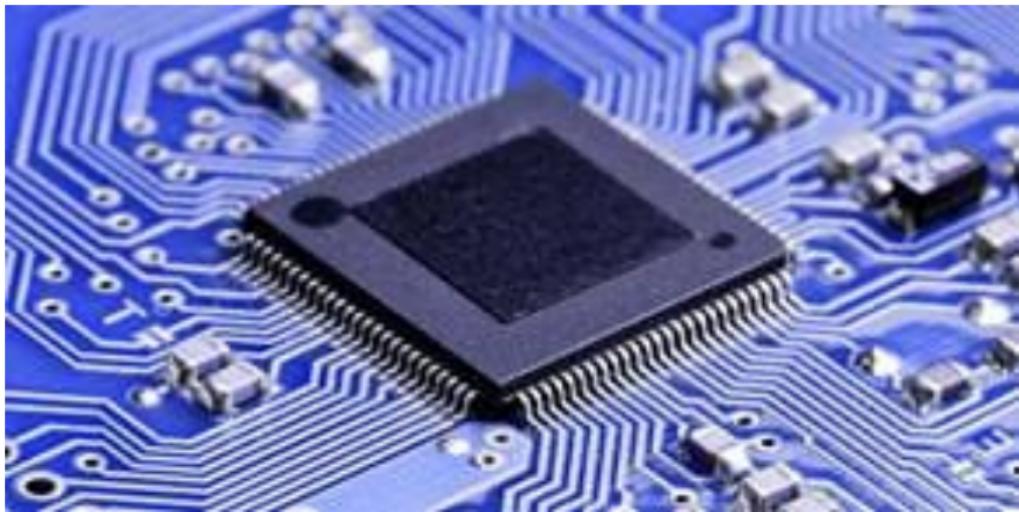


# oneButton LED

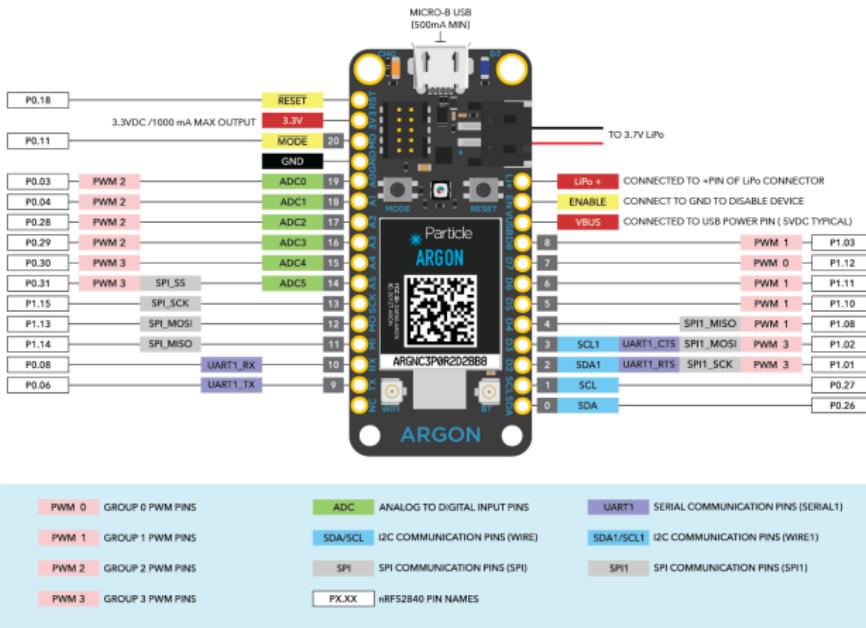


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# Our Second Microcontroller



# Particle Argon Pin Layout



v1.0