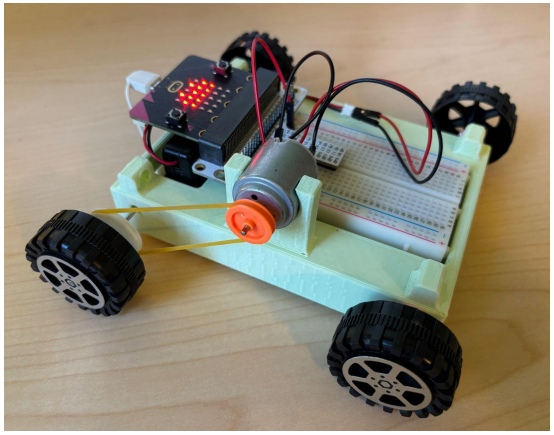
GO EV!

Build-Code-Test a Mini Electric Car



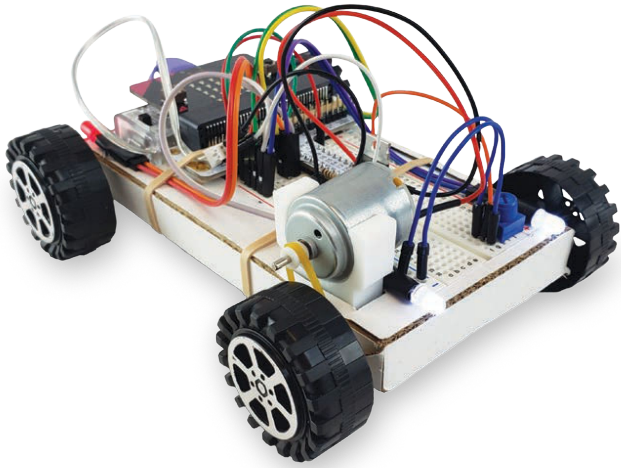
Engineering
UNIVERSITY OF COLORADO **BOULDER**

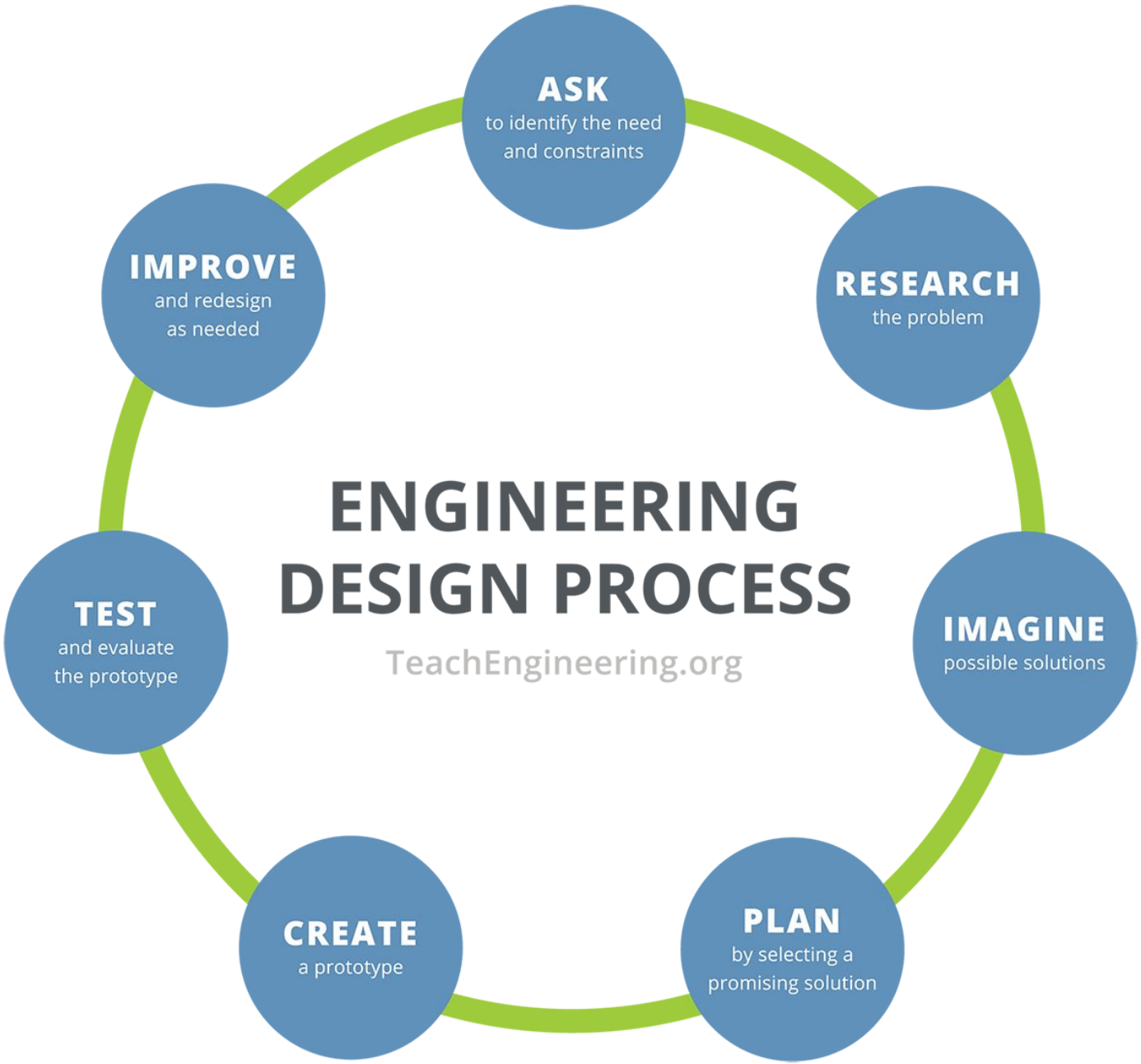
INTEGRATED TEACHING & LEARNING
Program and Laboratory

Overview

In this activity, you will use the **Engineering Design Process** to create a model Electric Vehicle, also known as an **EV**:

1. Build an EV Micro-Karts using provided materials and microcontrollers
2. Code an accelerometer to graph the EV Micro-Kart's movement





DESIGN THINKING SKILLS

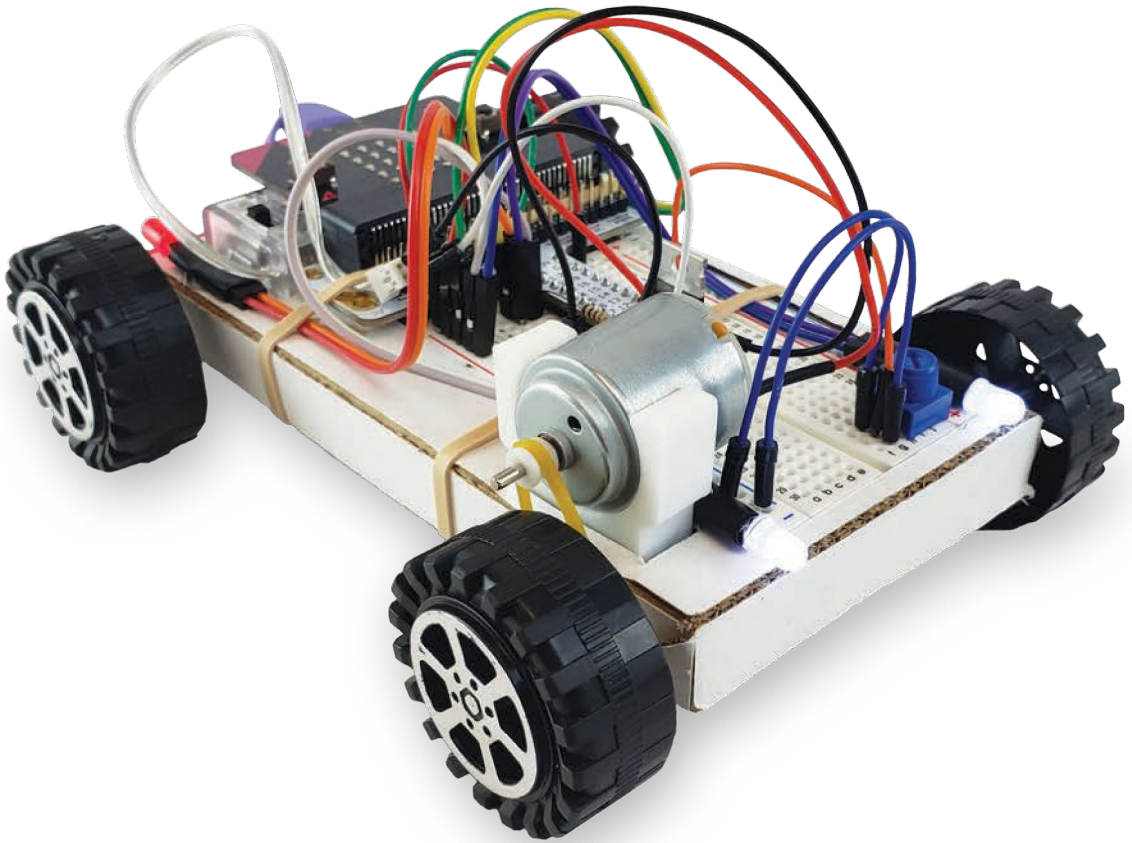
TeachEngineering.org

- FORMULATING PROBLEMS
- SEEKING SOLUTIONS
- THRIVING IN UNCERTAINTY
- COLLABORATING CONSTANTLY
- PROTOTYPING IDEAS
- ITERATING OPTIONS
- REFLECTING FREQUENTLY

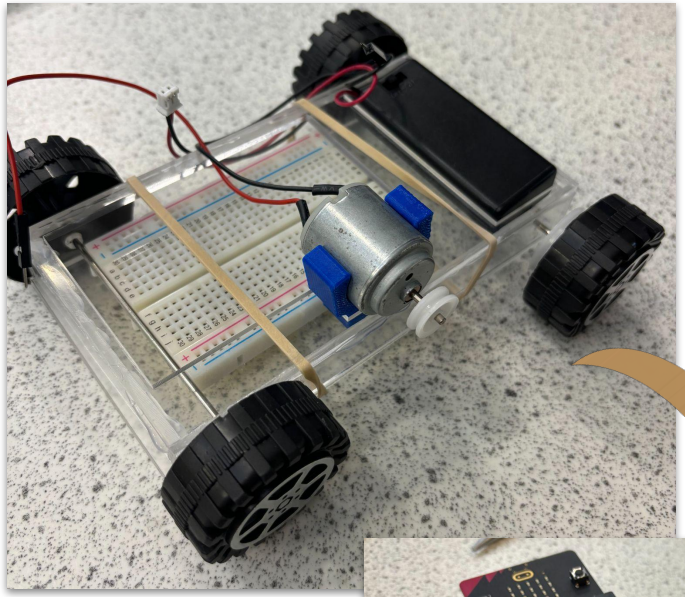
Building the EV Micro-Karts

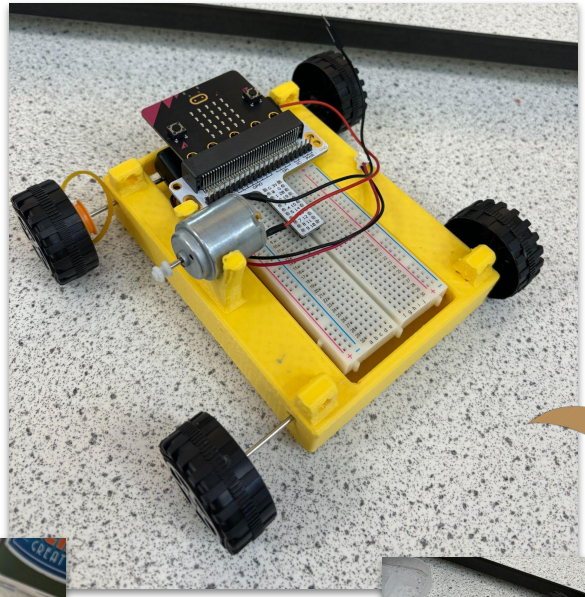
First, what material does it look like the original kart **chassis** (car body) is made of?

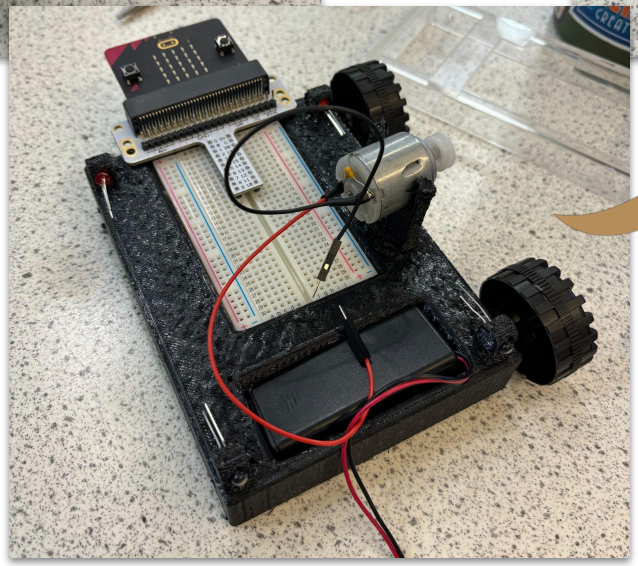
- Is this a good material for an engineer to use, why or why not?
- What other chassis materials would be better to use, why?

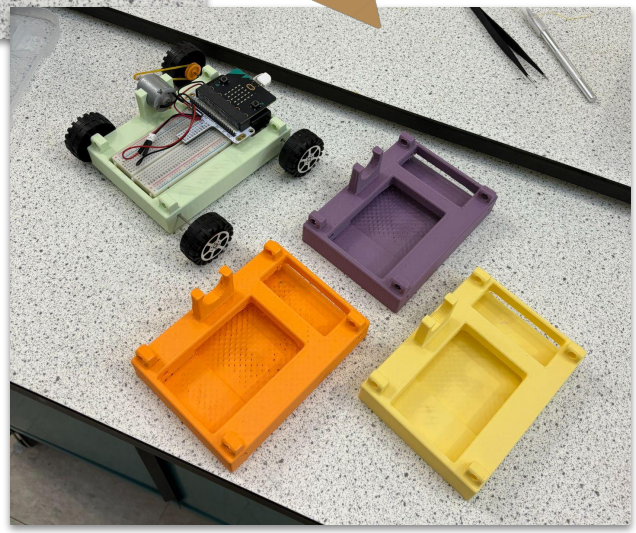


We used the Engineering Design Process to find the best design and material for the kart chassis!

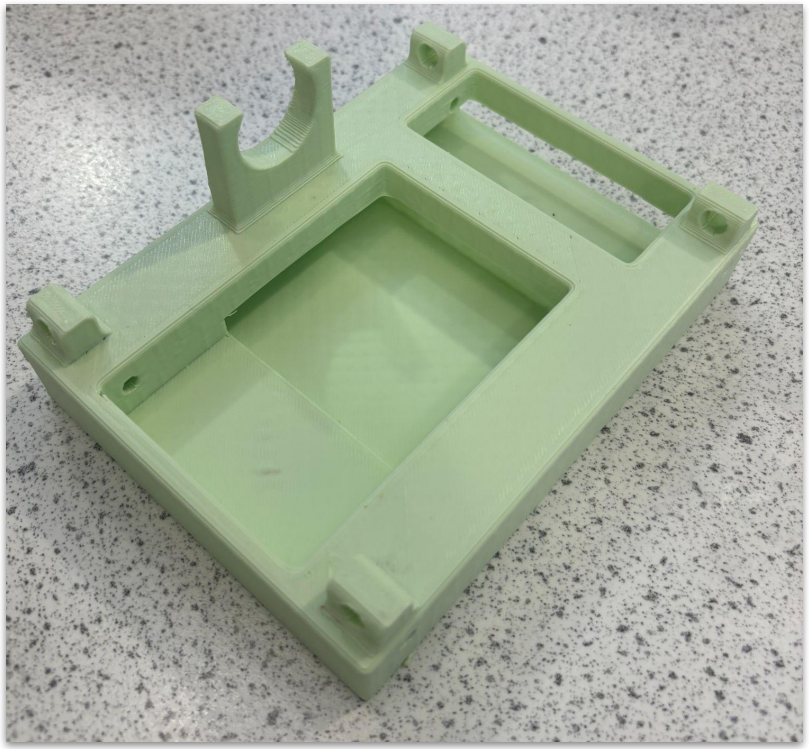




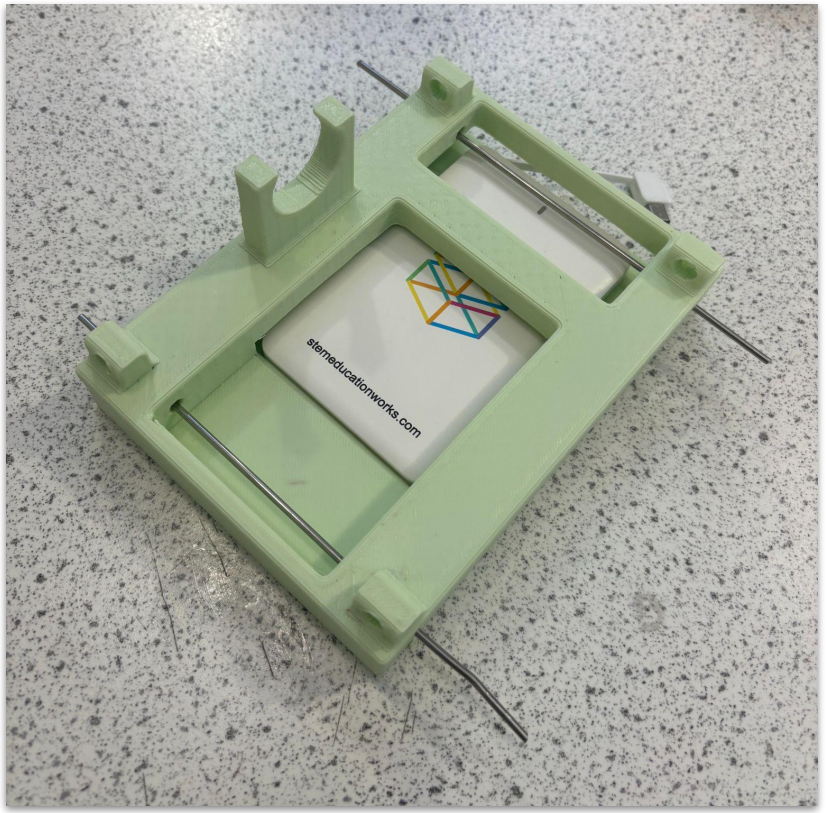




Build Your Chassis

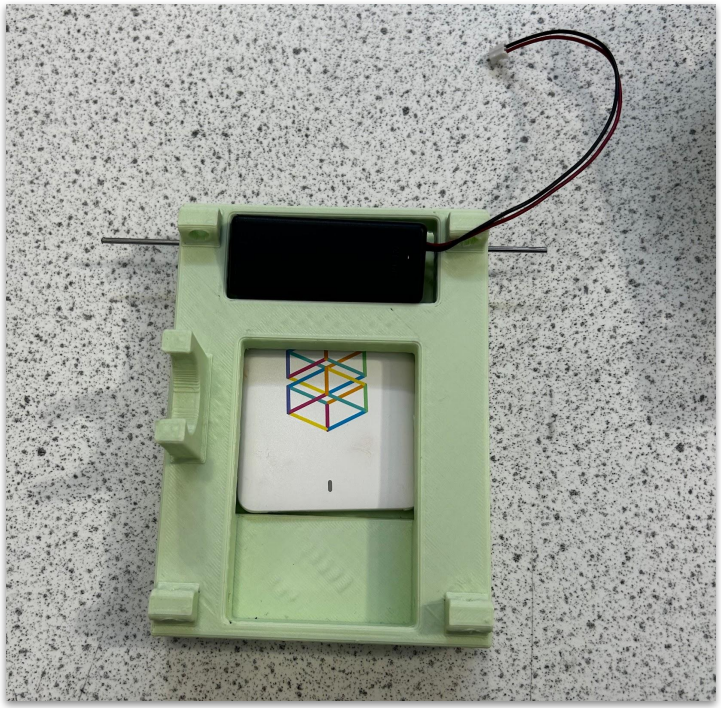


1. Grab the **chassis** out of your kit

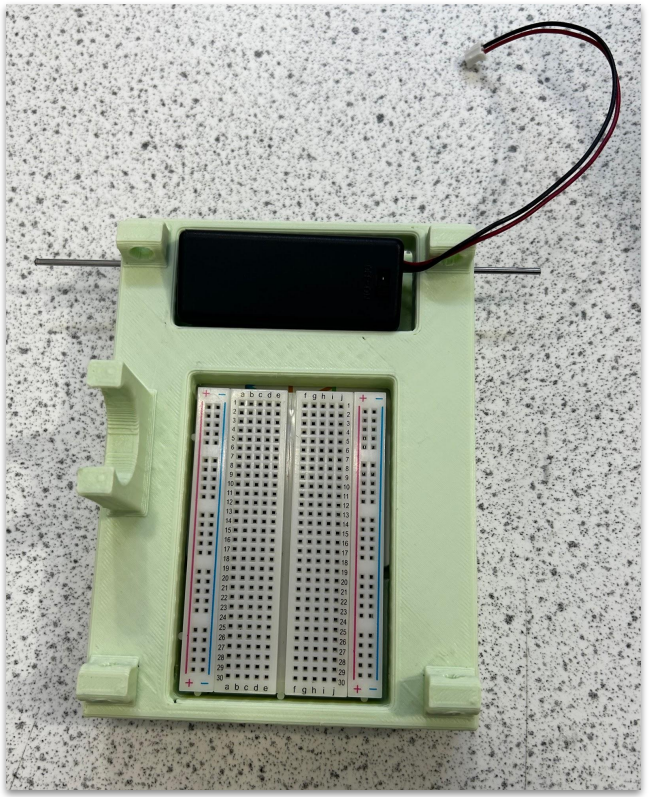


2. Slide the **white battery** pack into the bottom opening and insert the **axles**

Build Your Chassis



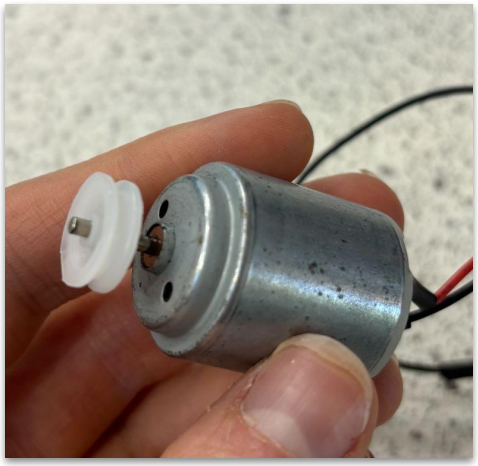
3. Place the **black battery pack** in the small rectangle cut-out



4. Place the **breadboard** in the large rectangle cut-out

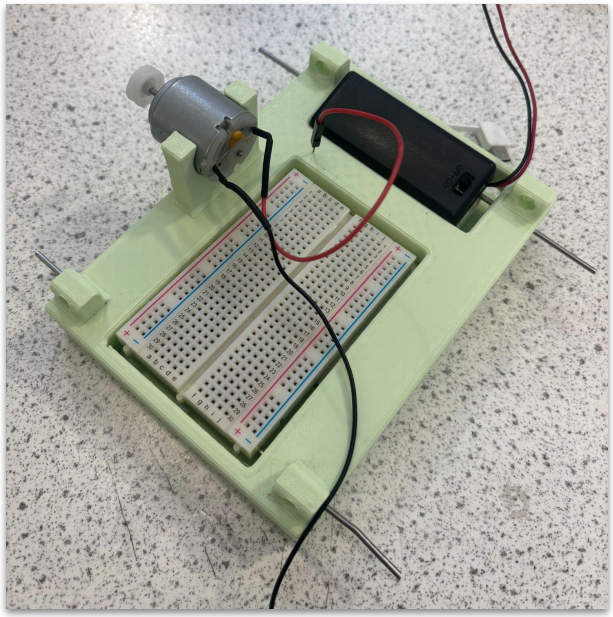
Build Your Chassis

Make sure your motor has a pulley attachment! Call one of us over if your motor has a gear!

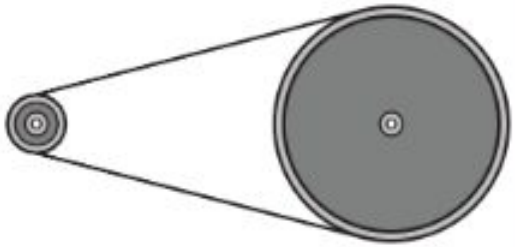


This is what your motor should look like!

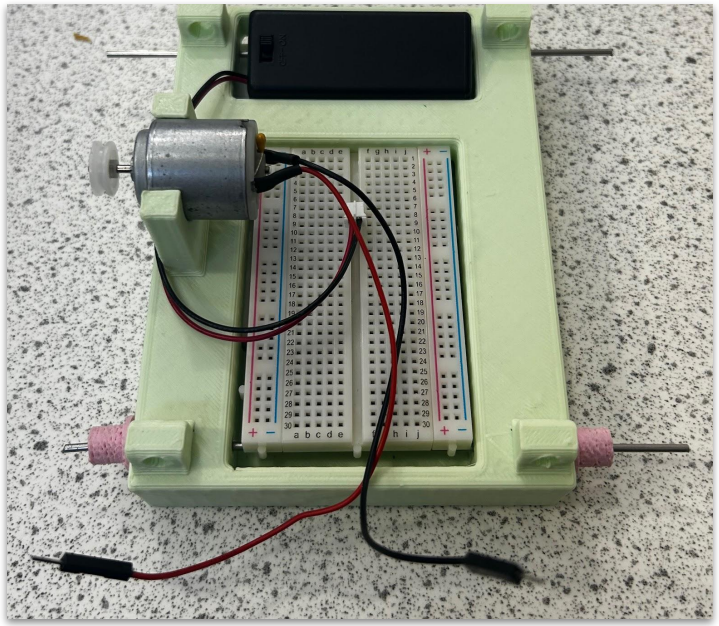
5. Place the **motor** into the motor mount, gently slide it in from the side!



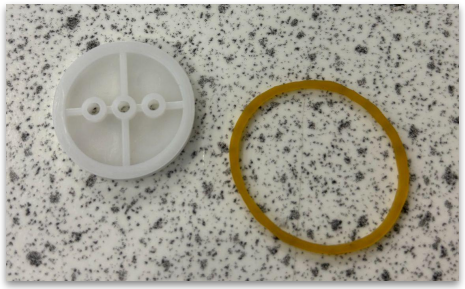
Pulley Ratios: Speed vs Torque

	Pros	Cons
Small Pulley Ratio 	Small radius of driven pulley yields higher RPM output, resulting in a higher maximum speed (**good** for **long-distance races**)	Small radius of driven pulley yields lower torque output, resulting in lower acceleration (**bad** for **short-distance races**)
Large Pulley Ratio 	Large radius of driven pulley yields higher torque output, resulting in higher acceleration (**good** for **short-distance races**)	Large radius of driven pulley yields lower RPM output, resulting in a lower maximum speed (**bad** for **long-distance races**)

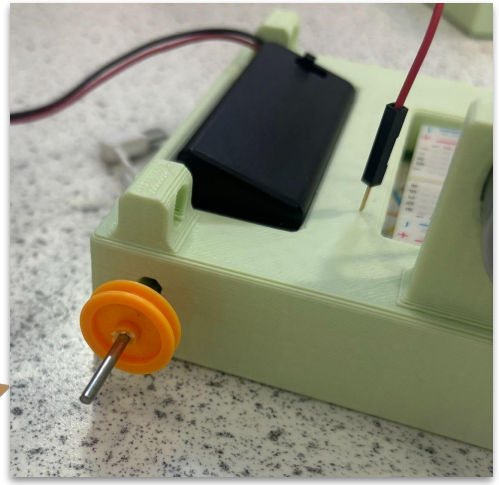
Build Your Chassis



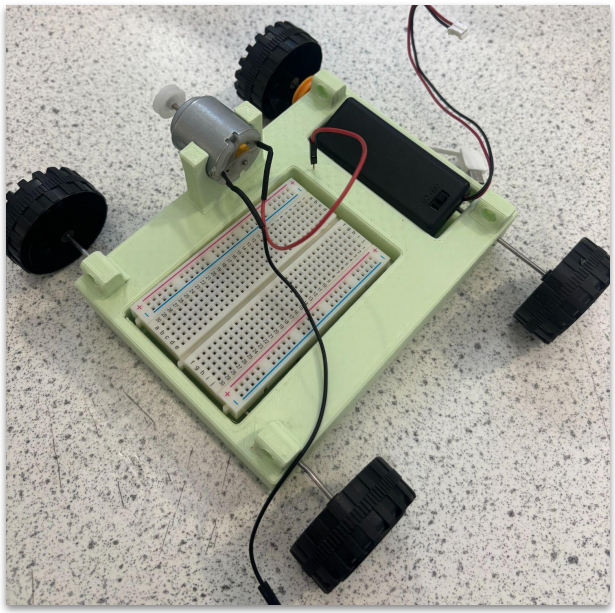
6. Put two **spacers** on the **front axle**



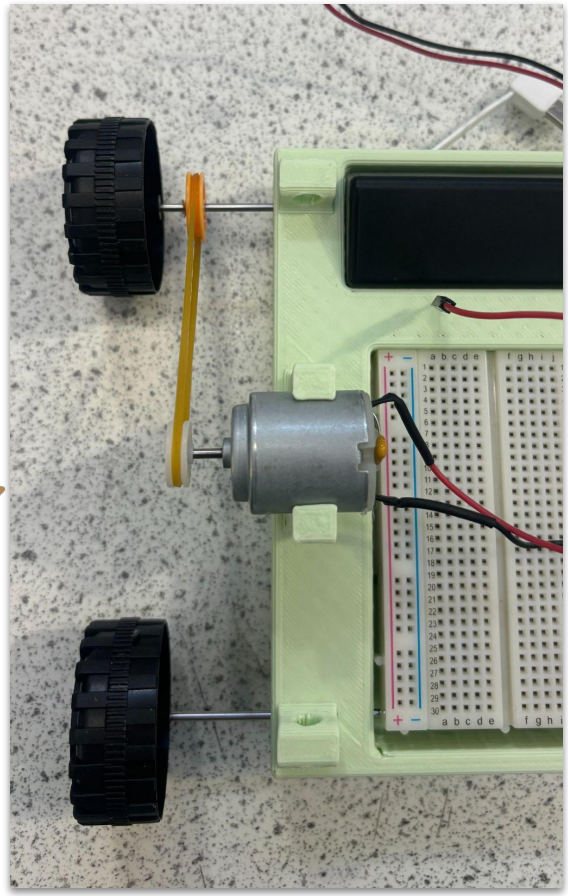
7. Chose another **pulley** and a small **rubber band**. Attach this pulley to the **back axle** of your kart



Build Your Chassis



8. Attach the **wheels** to the axles



9. Put the **rubber band** on the **back axle pulley** and the **motor pulley**

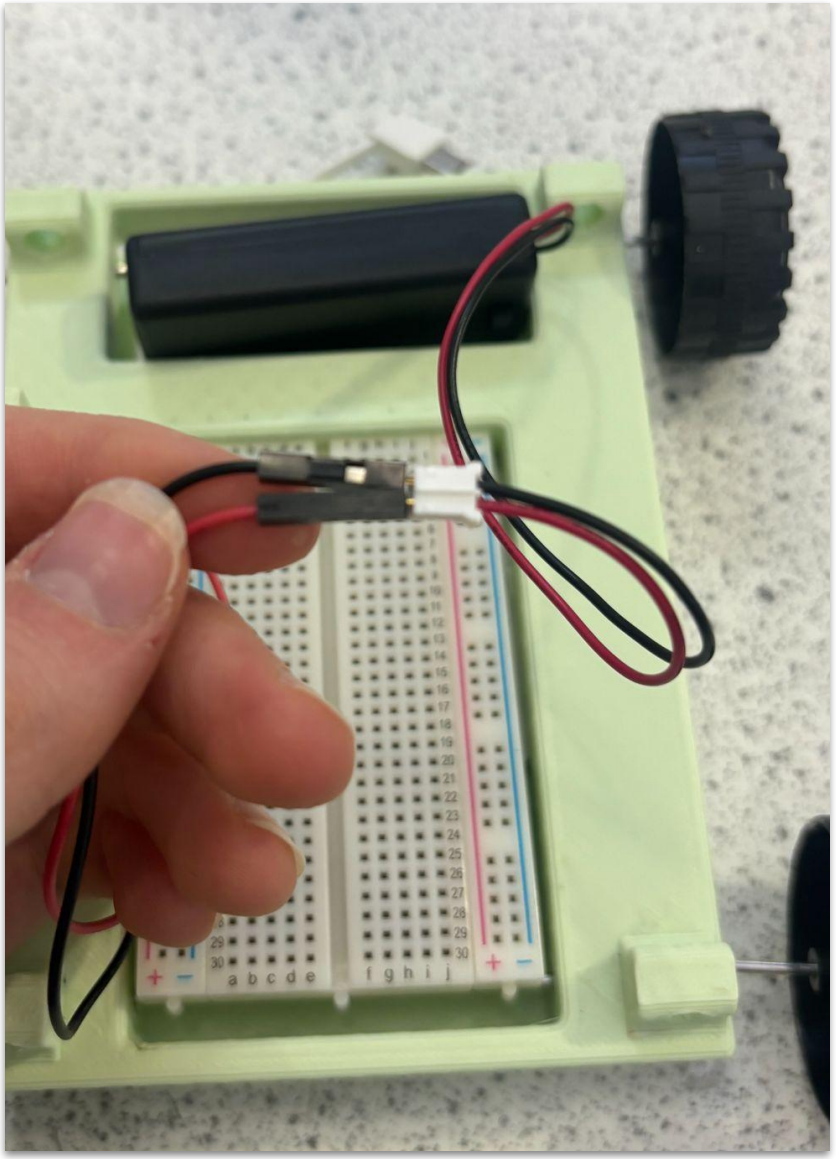
Try to make sure the pulleys and rubberband are in line with each other!

Let's Test the Motor!

1. Connect the **red wire of the motor** to the **red wire of the battery back**

2. Connect the **black wire of the motor** to the **black wire of the battery back**

3. Turn on the battery pack, do the wheels spin? Do they spin forward or backward?



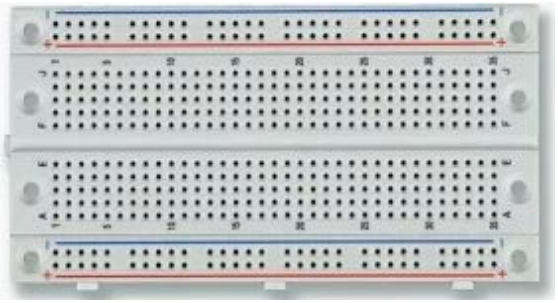
Power the Motor

Motor Materials

Locate the following components in your kit:

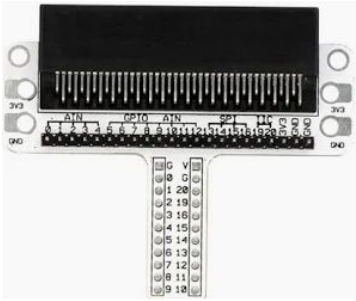
- Micro:bit

- Breadboard

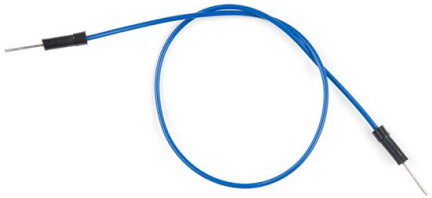


- Motor

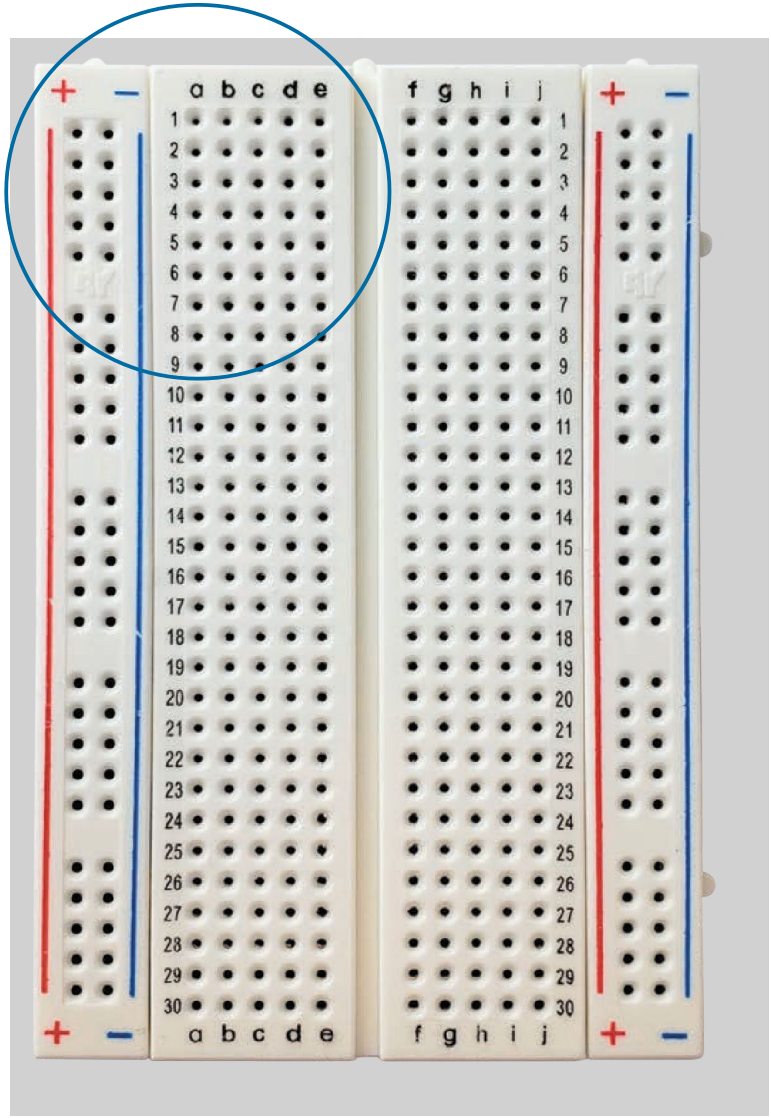
- Micro:Bit breadboard adaptor



- Four M/M wires

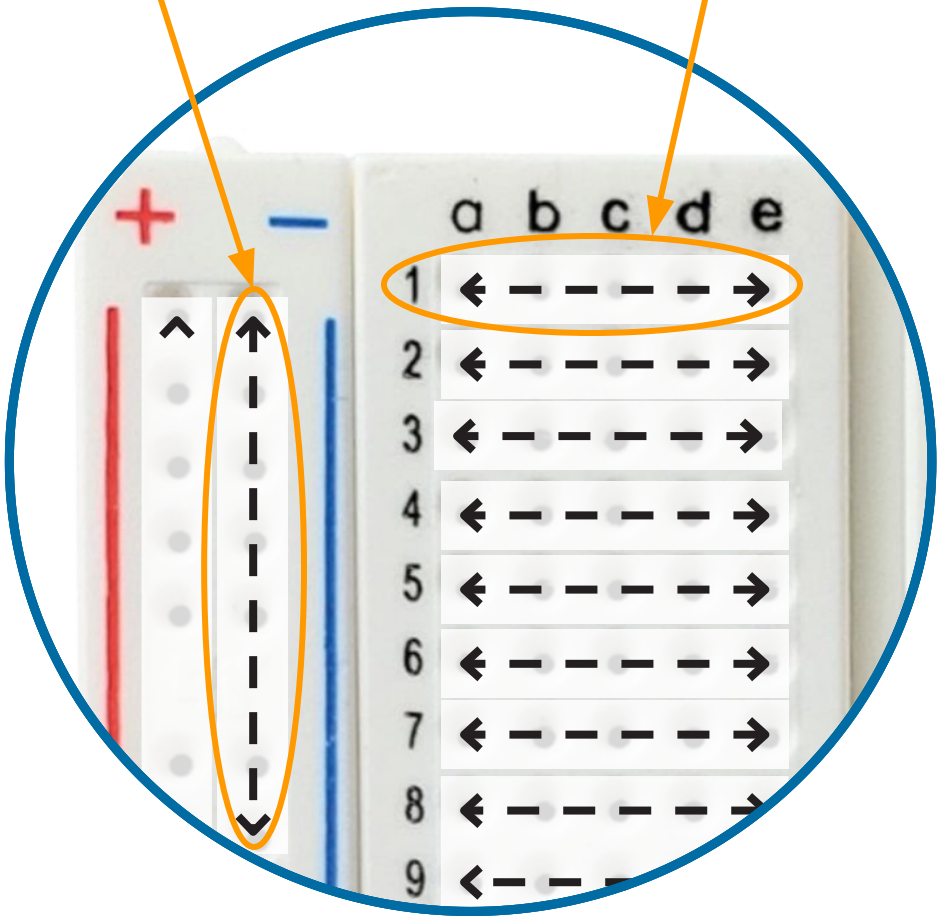


Breadboard Basics

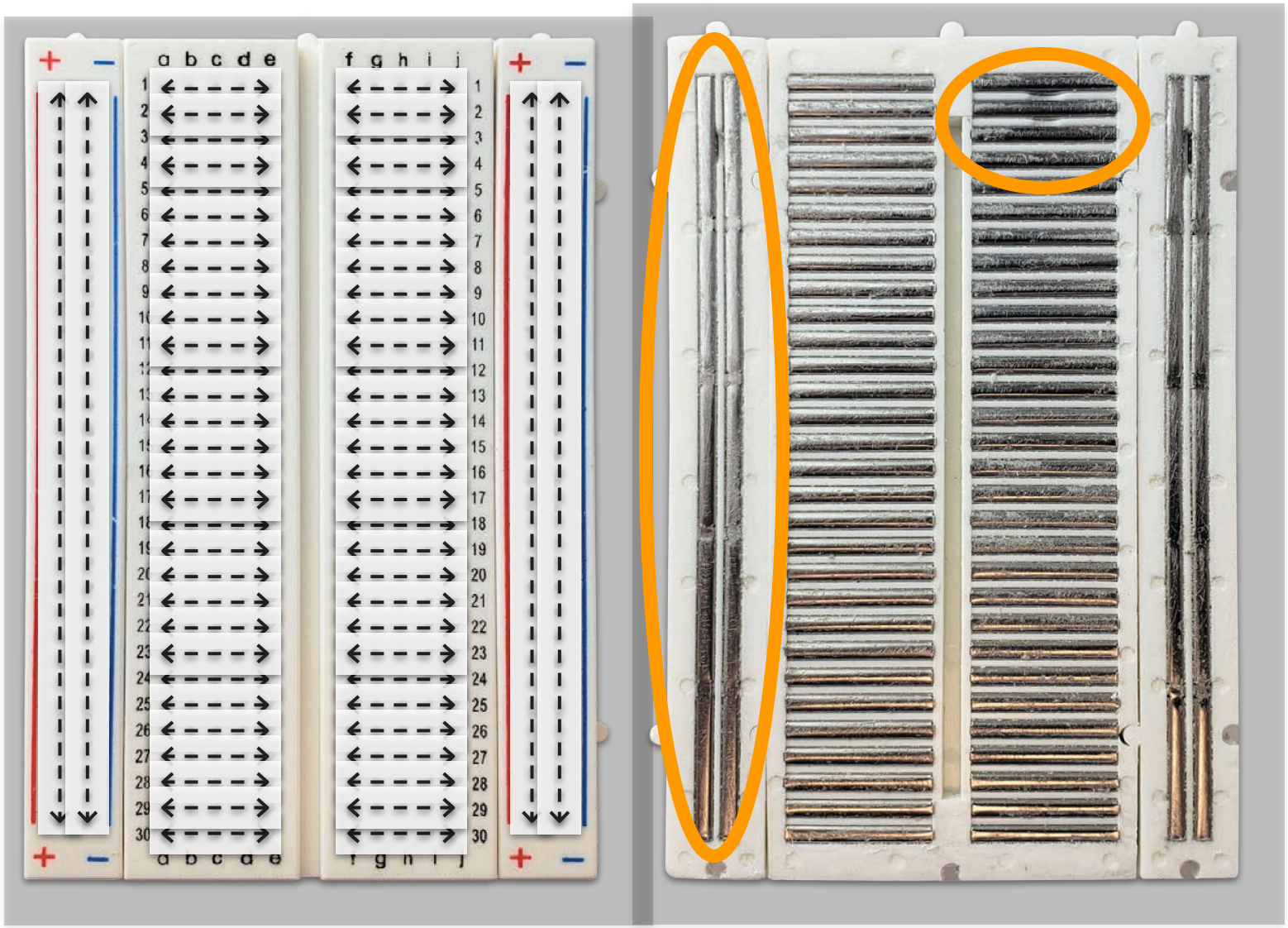


Power rails are connected by column

Terminal strips are connected by row

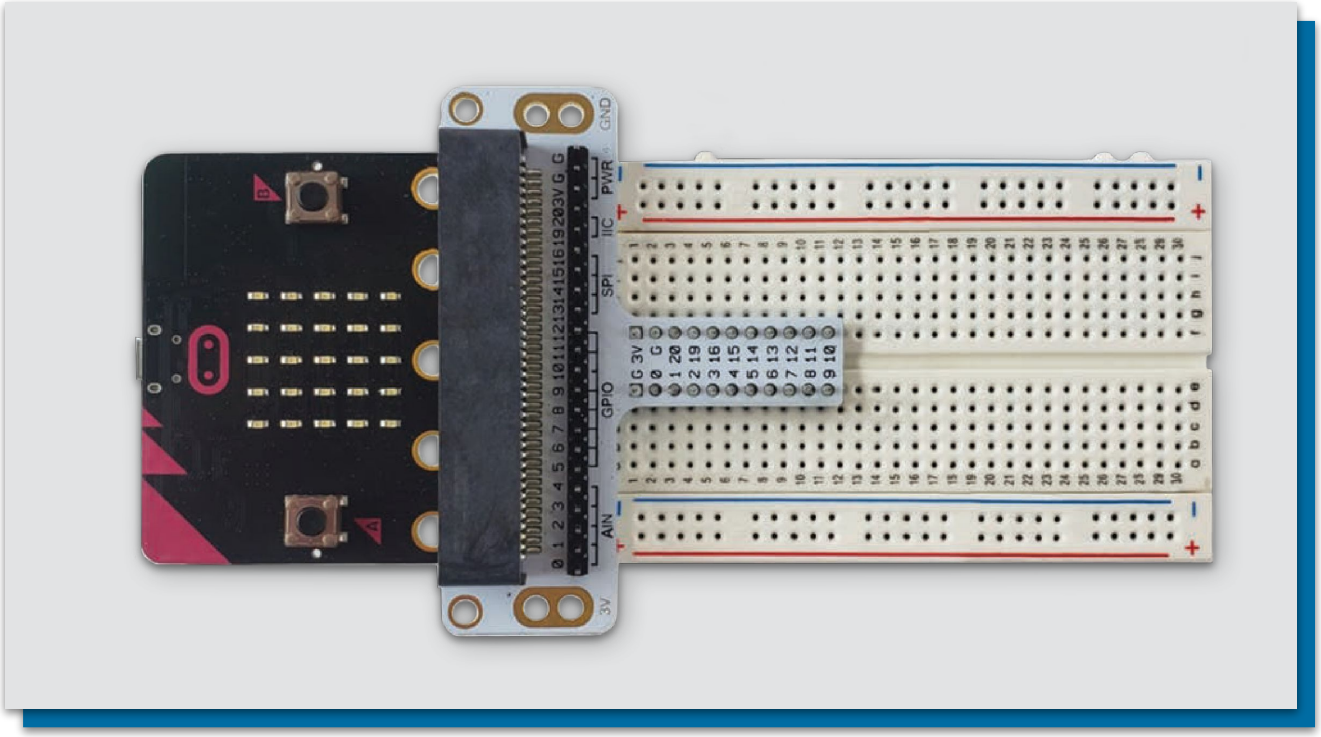


Breadboard Basics



Attaching the Breadboard Adaptor

The Micro:bit should sit above the black battery pack



- Slide the **micro:bit** into the **micro:bit breadboard adapter**
- Press the adapter gently but firmly into the top of the breadboard, into holes **E1** to **E11** and **F1** to **F11**

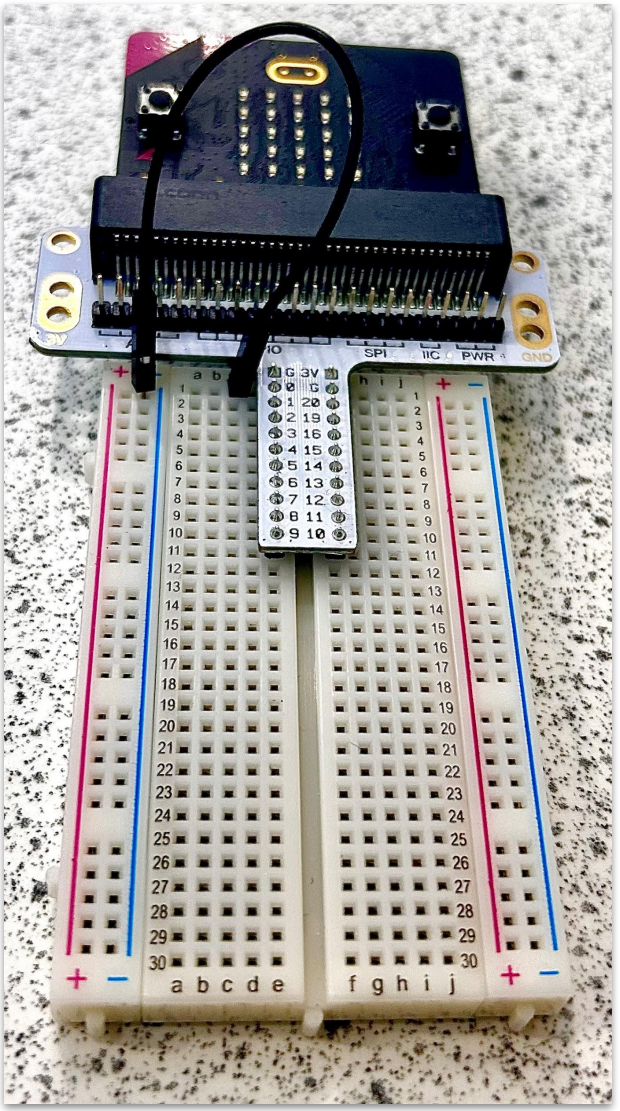
IMPORTANT: Keep Circuits Safe!

Whenever wiring or rewiring a circuit, make sure the **power source is DISCONNECTED!**

➔ Keeping the power connected when wiring circuits can damage components!

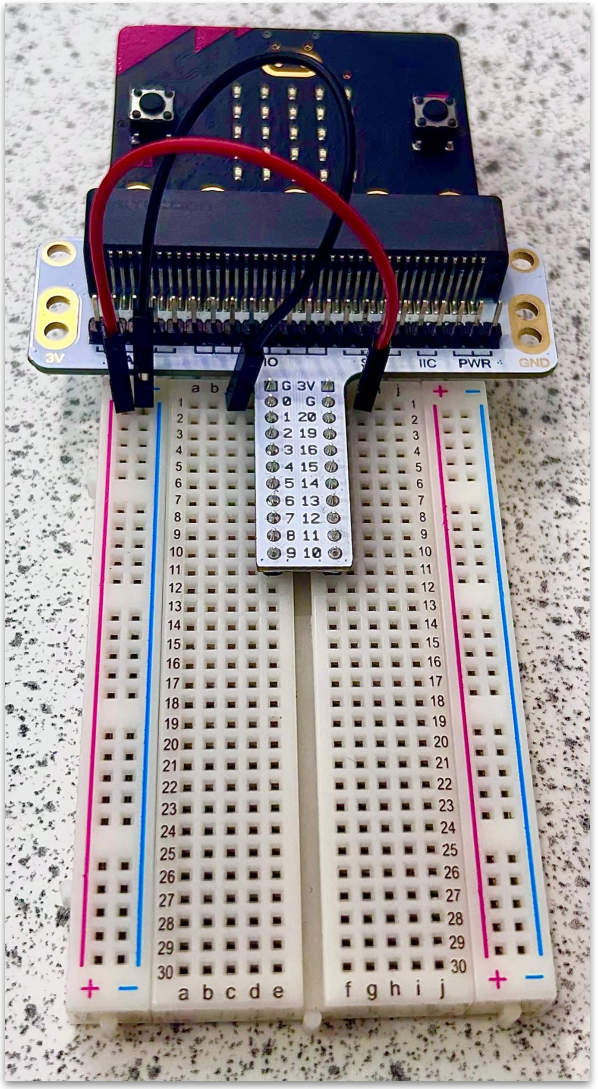
Supplying Power to Your Breadboard

- Place one end of an **M/M wire** into hole **D1** (next to the G/ ground pin of the breadboard adapter)
- Place the other end into **any hole on the negative rail**



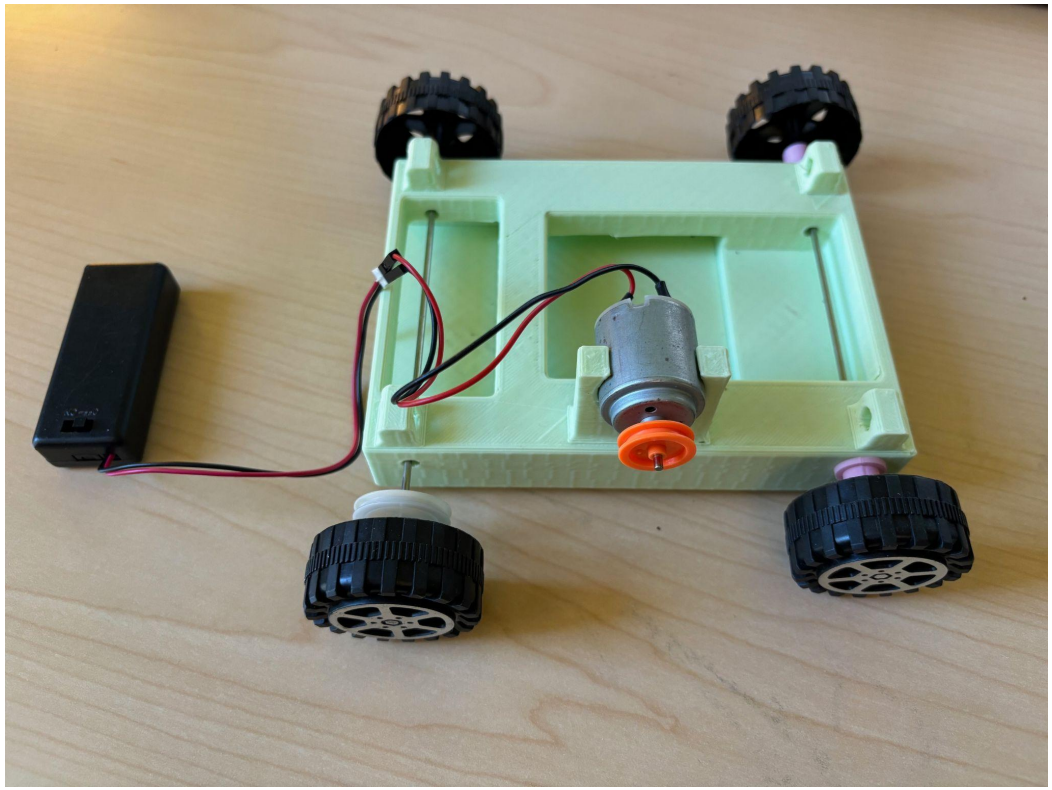
Supplying Power to Your Breadboard

- Place one end of an **M/M wire** into hole **H1** (next to the 3V pin of the breadboard adapter)
- Place the other end into **any hole on the positive rail**



Placing the Motor

- Locate the wire leads from your motor. Plug the motor's **red positive lead** into the battery pack **red positive port**
- Plug the motor's **black negative lead** into the battery pack **black negative port**



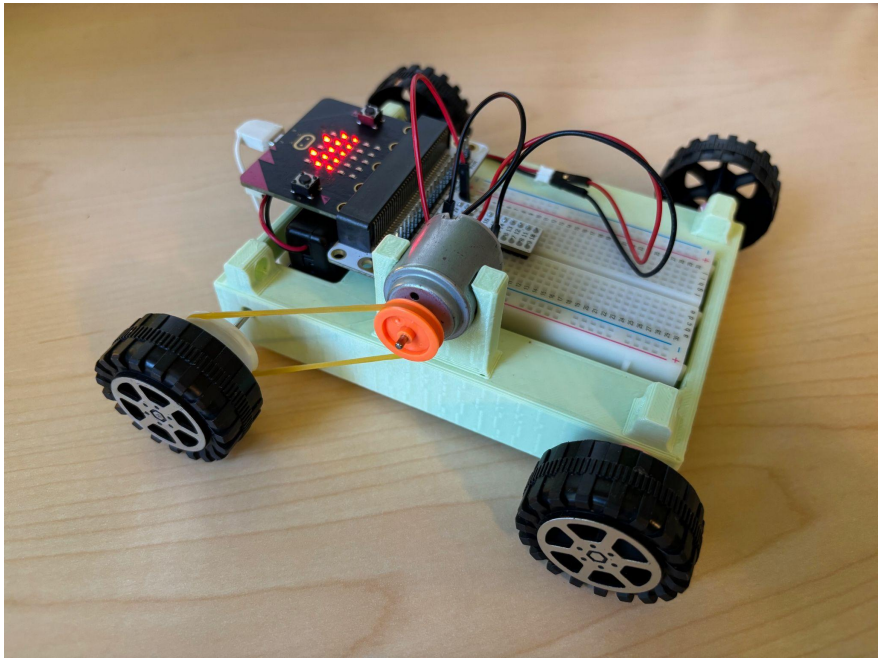
Test Your Wiring and Coding

- Plug the white battery pack into the micro:bit and turn on the black battery pack
    - Slide the wire out of the battery pack to get the micro USB

EV Micro-Kart Test Drive!

- With a partner, test your the EV Micro-Kart to see how it moves.
- **The EV Kart can't stop on its own so make sure you catch it!**

Back

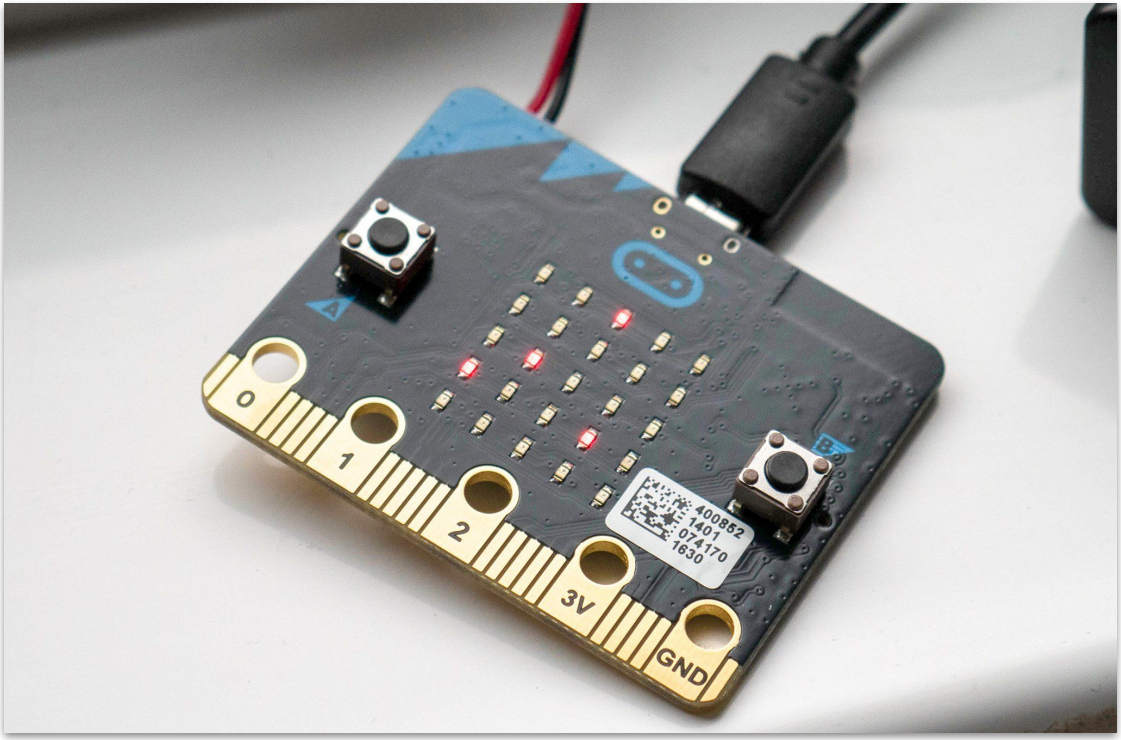


Front

Accelerometer

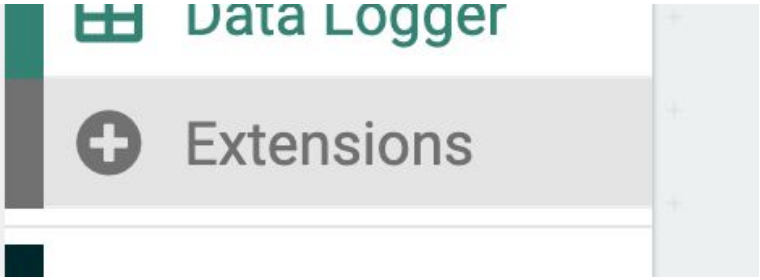
What is an accelerometer?

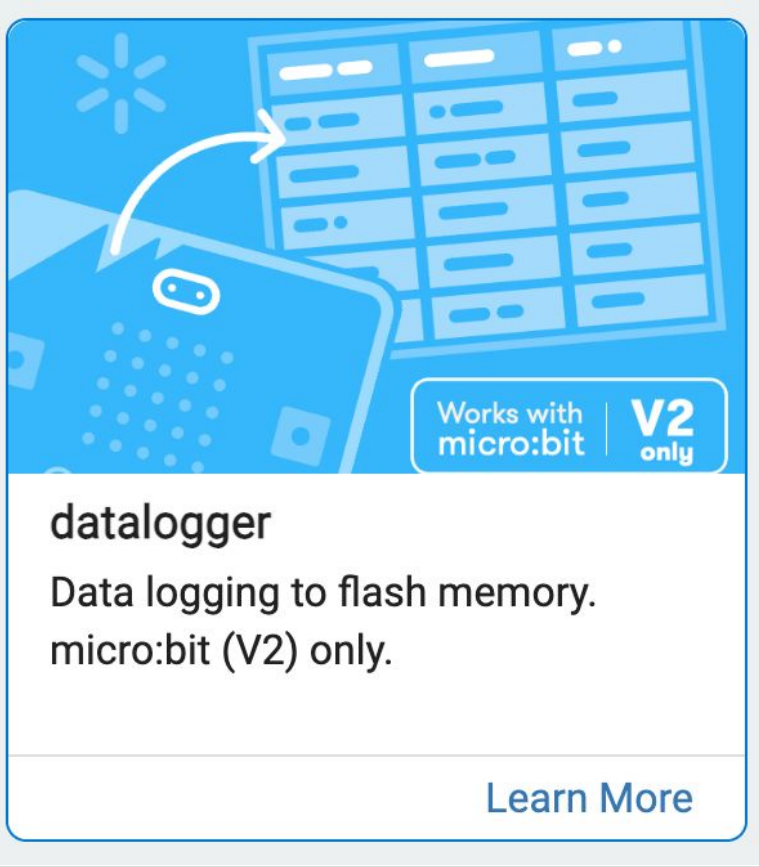
An accelerometer is a sensor that measures the “acceleration” of an object. Acceleration is defined as how fast an object’s speed changes over time! The micro:bit has a built in accelerometer!



New Code Blocks!

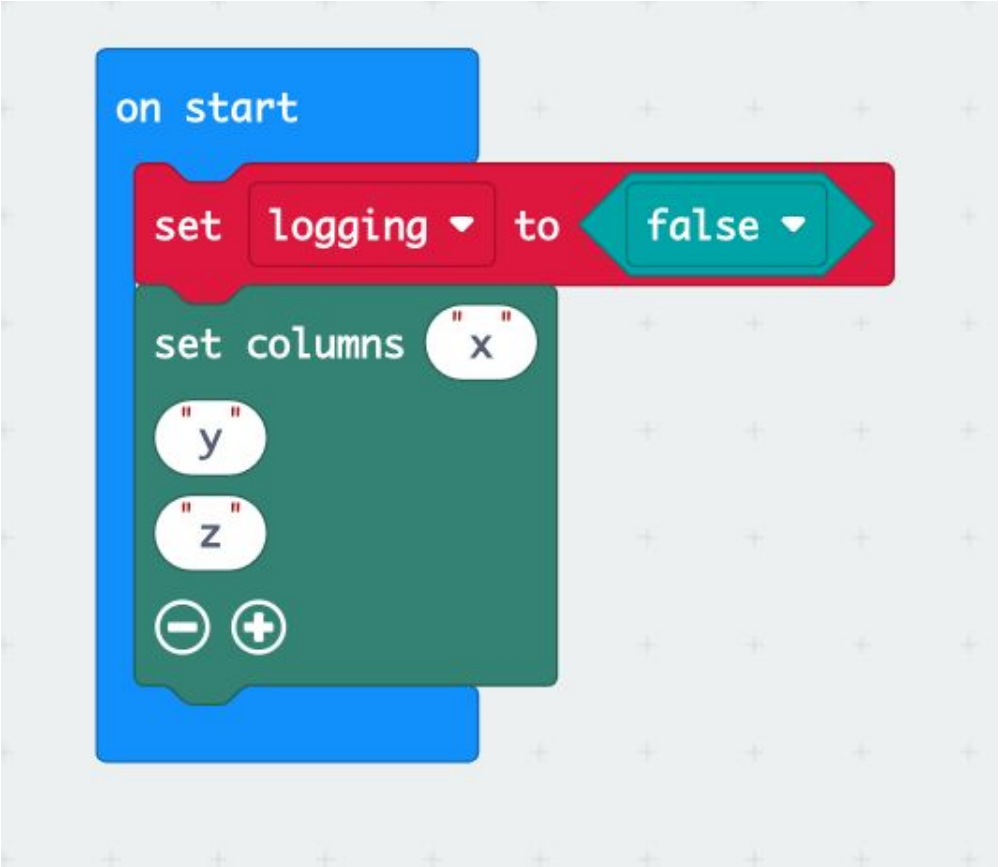
- Go to the **Extensions** tab and find the data logging extension
- Find the **Datalogger** extension and click on it to add it to your block library





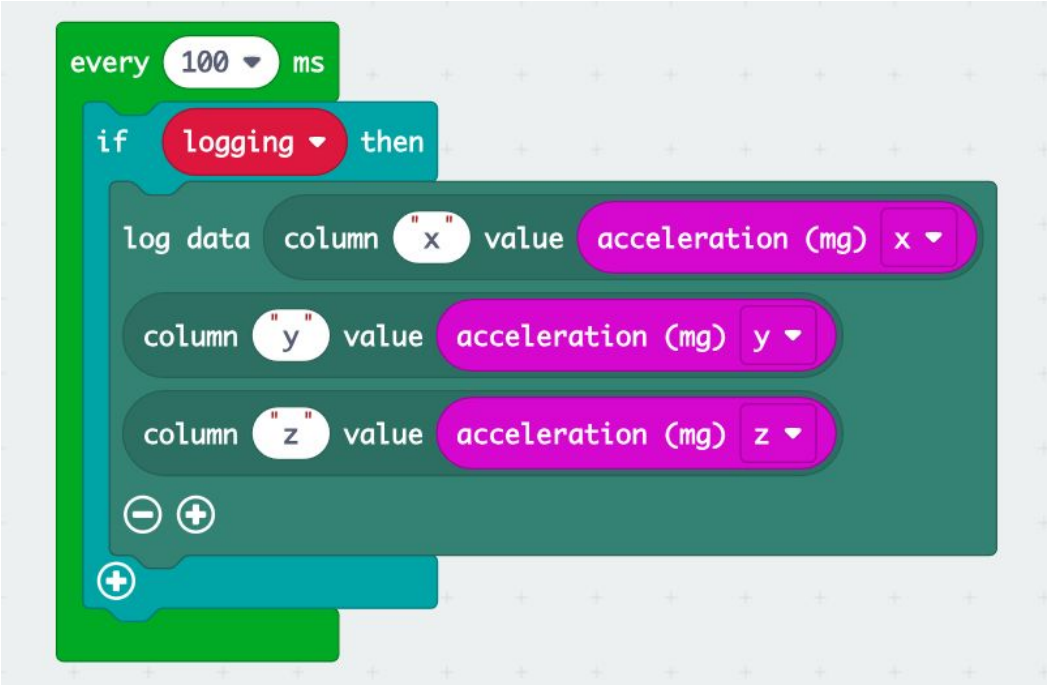
Code Your Accelerometer

- Go to the **Variables** menu and make a variable called "**logging**"; set logging to "**false**" (find "false" under **Logic**)
- Grab the "**set columns**" block from the new **data logger** menu and click the plus '**+**' twice to add two more rows
- Type **x**, **y**, and **z** in each of the boxes



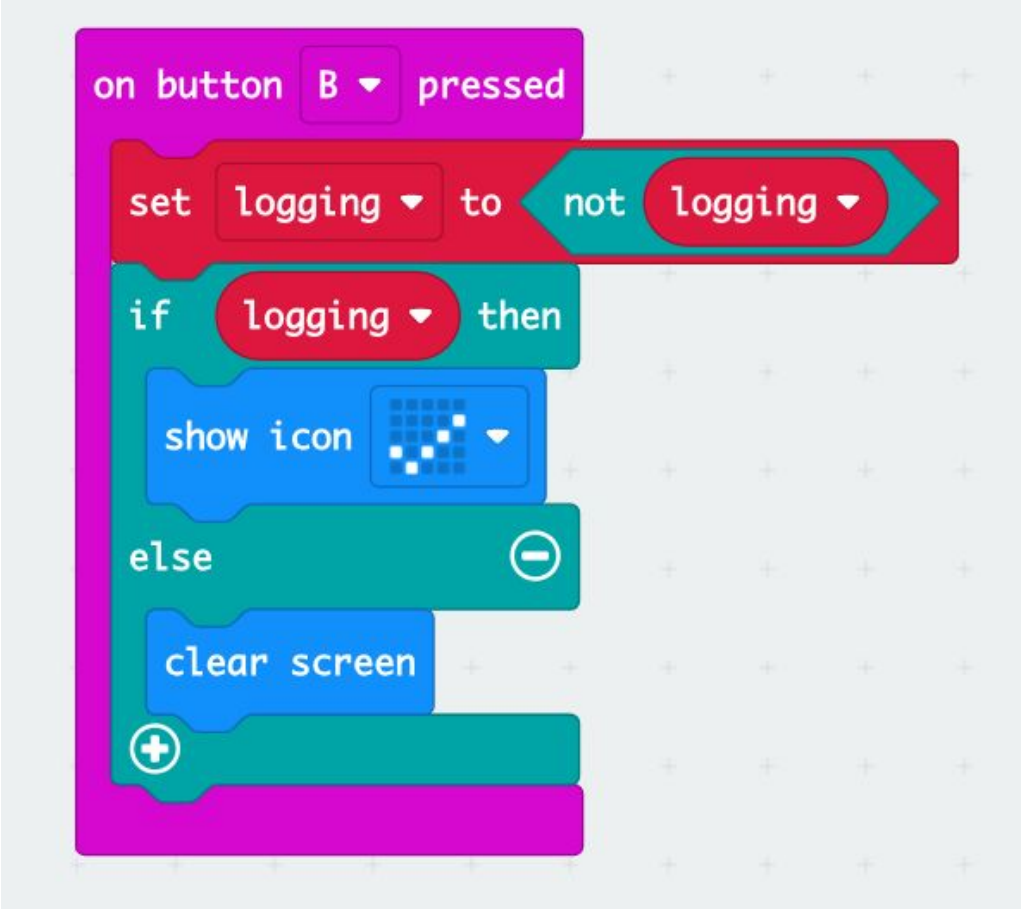
Code Your Accelerometer

- In the **Loops** menu grab the "**every 500 ms**" block and change it to **100 ms**
- Grab an "**if __ then**" statement from the **Logic** menu, and put "**logging**" after "**if**"
- From the **Data Logger** menu grab the "log data" block and click the "**+**" twice. Type **x**, **y**, and **z** in the value spaces
- From the **Input** menu grab three "**acceleration (mg) __**" blocks and change two to y and z and put them in the last space next to value



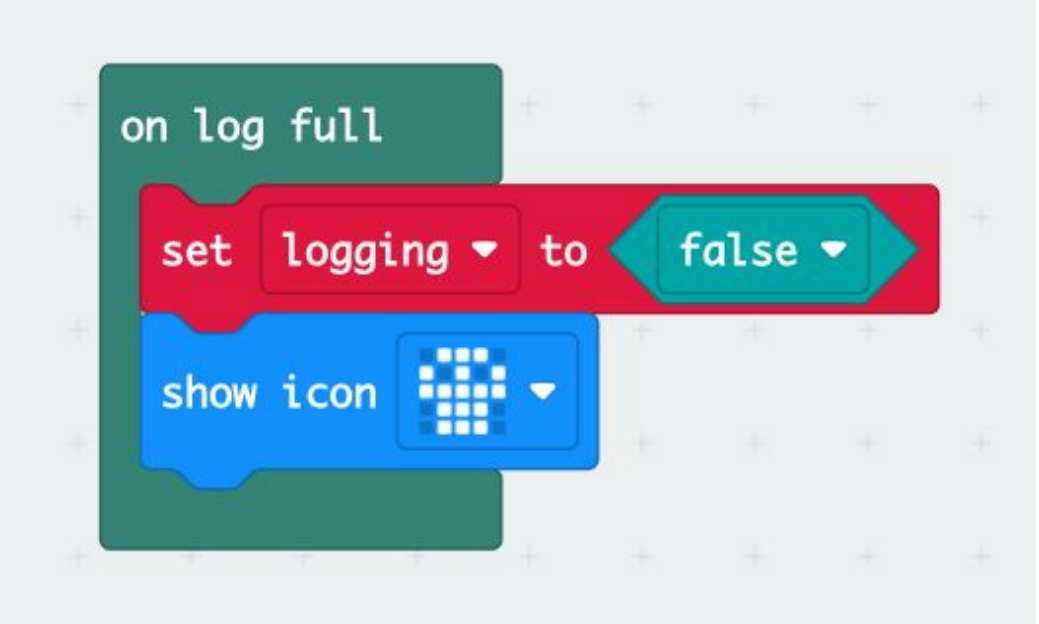
Code Your Accelerometer

- Navigate to the **Inputs** menu, and select **“on button B pressed”**
- If this button is clicked and we are logging, we want to stop logging; on the flip side if we are not logging and the button is clicked we want to start logging
- The **“not __”** button can be found in the **inputs** menu
- If we are logging we want the screen to display a **checkmark**



Code Your Accelerometer

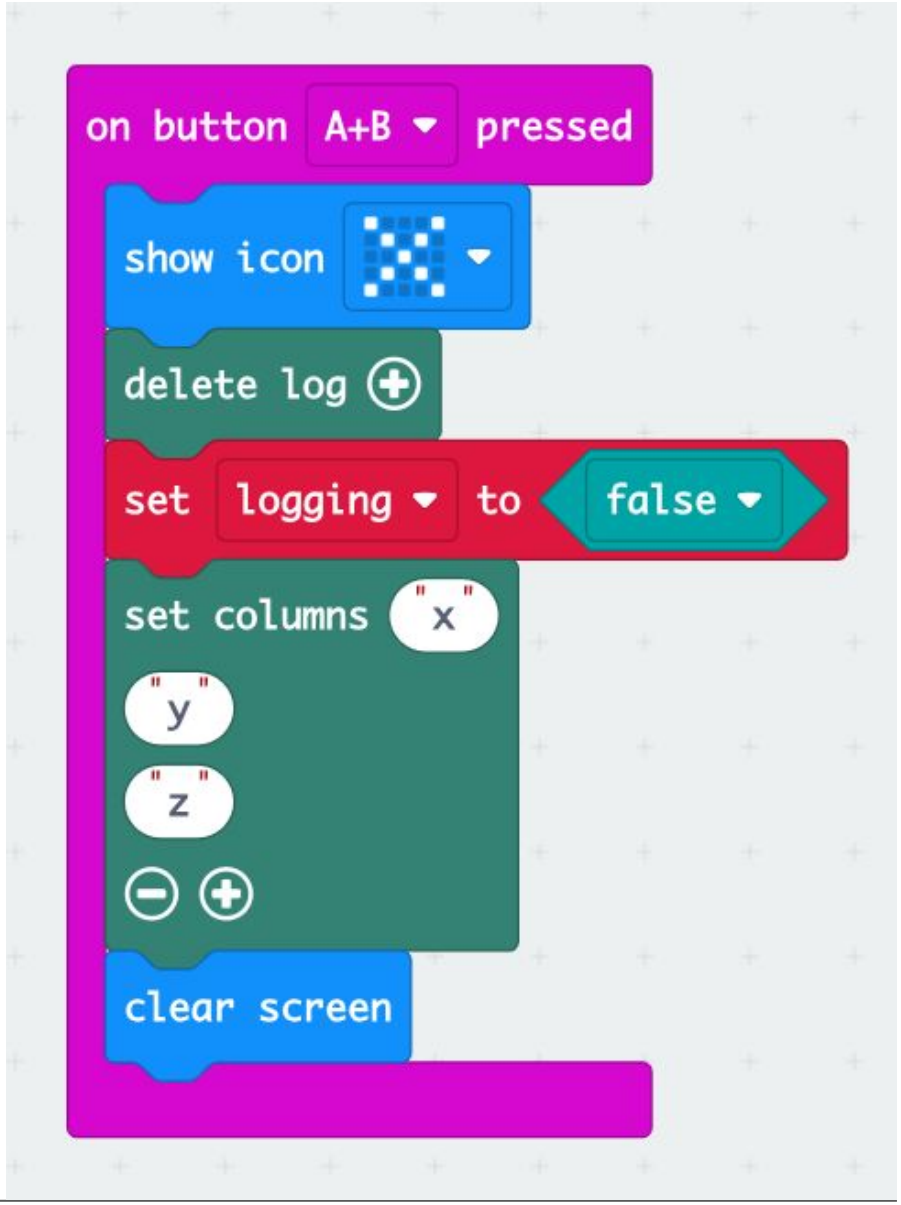
- Navigate to the **Data Logger** menu, and select **“on log full”**
- If there is no more storage we need to get rid of it
- grab a **“set logging to __”** from the **Variables** menu and a “**false**” block from the **Logic** menu to turn logging off
- We want a visual cue for why we aren’t collecting data so grab the **“show icon”** block from the **Basic** menu and select the skull



Code Your Accelerometer

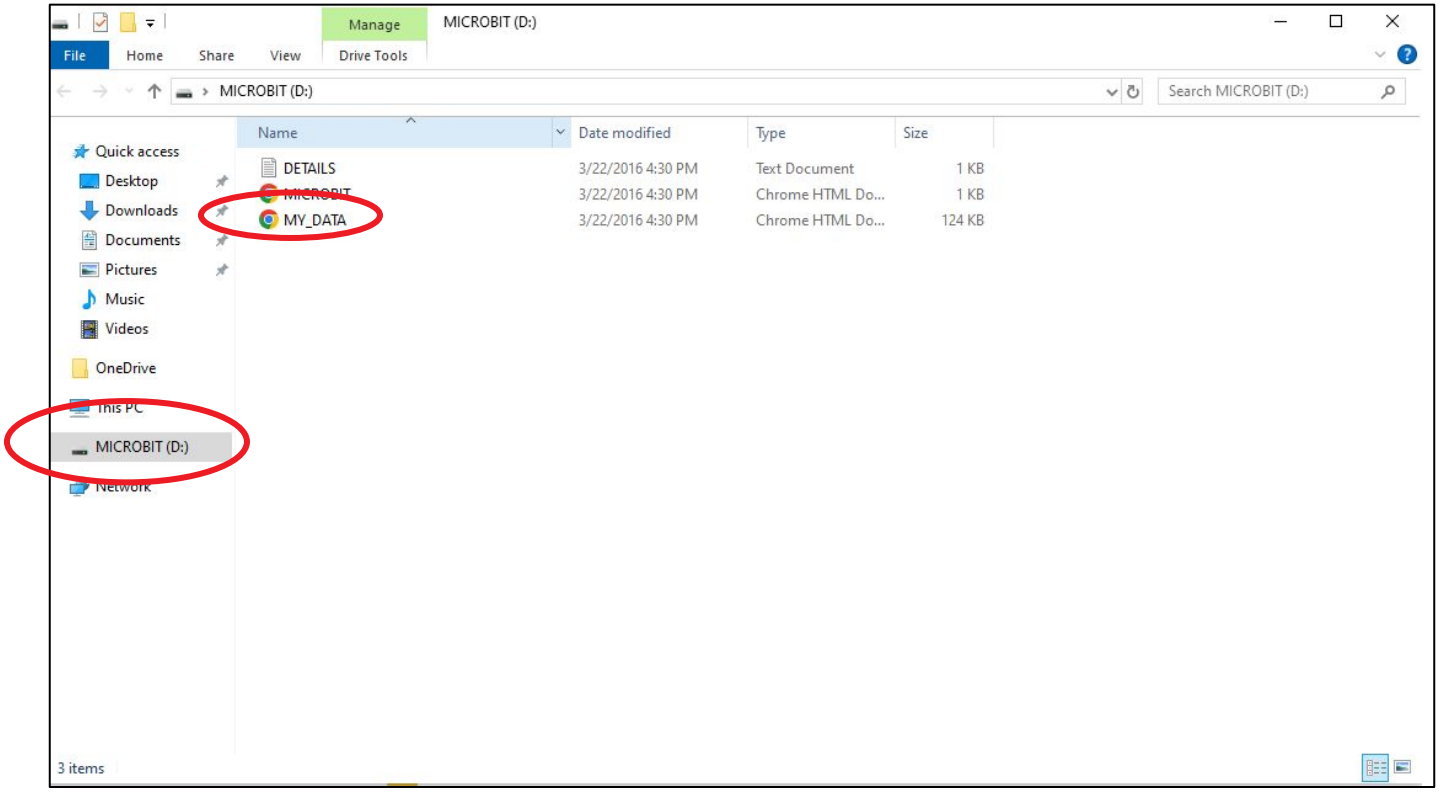
We now need a way to clear data:

- Grab a **“on button A pressed”** block from the **Inputs** menu and change it to **“A + B”**
- Grab a **“show icon”** block from the **Basic** menu and change the icon to an **“X”**
- Grab the **“delete log”** block from the **Data Logger** menu
- Grab a **“set logging to __”** from the **Variables** menu and a **“false”** from the **Logic** menu
- Grab a **“set columns”** block from the **Data Logger** menu and type in **x, y and z** in the spaces
- Grab a **“clear screen”** block from the **Basics** menu to clear the micro:bit to show its finished erasing data



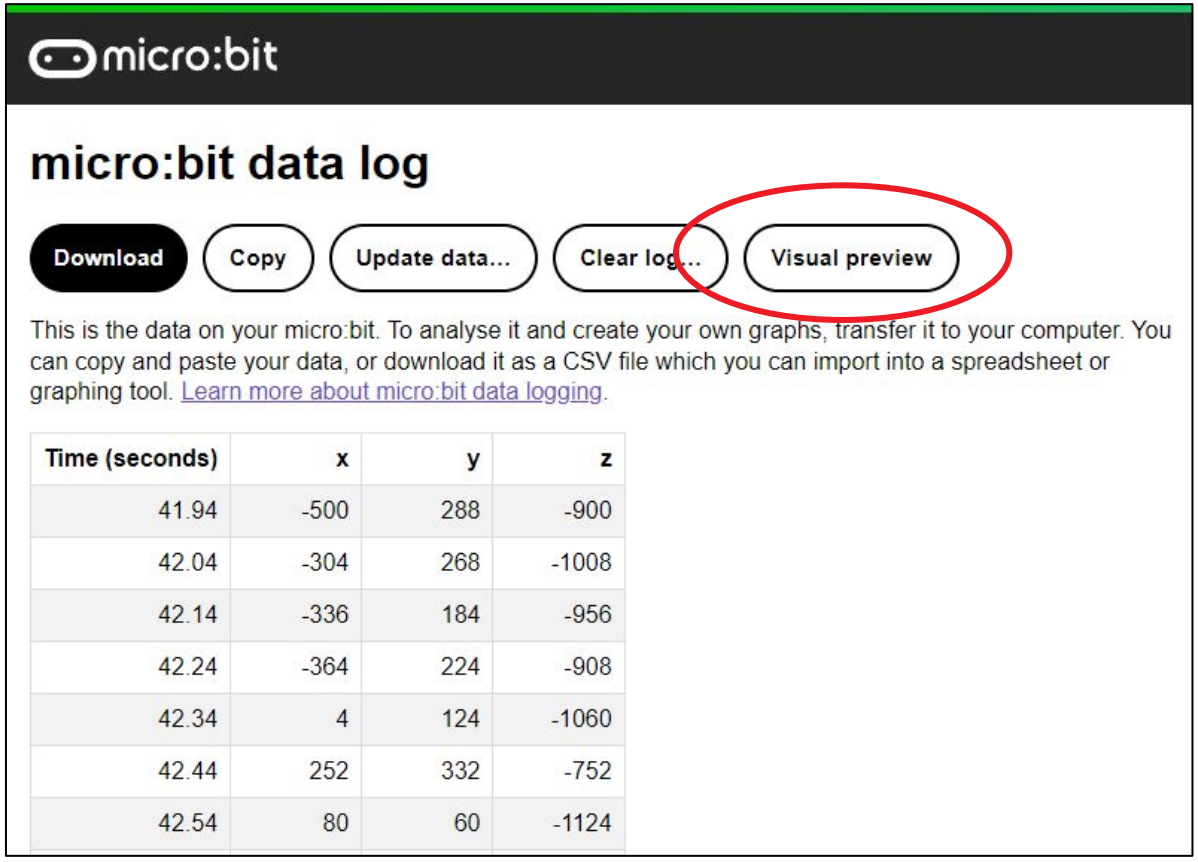
How to Find Your Accelerometer Data

- Plug in your micro:bit and open files (if it doesn't pop up automatically) and select the **MICROBIT** option on the side
- Click on "**MY_DATA**"



How to Find Your Accelerometer Data

- On this screen you can view the data table!
- Click on **Visual Preview** to view data in a graph!

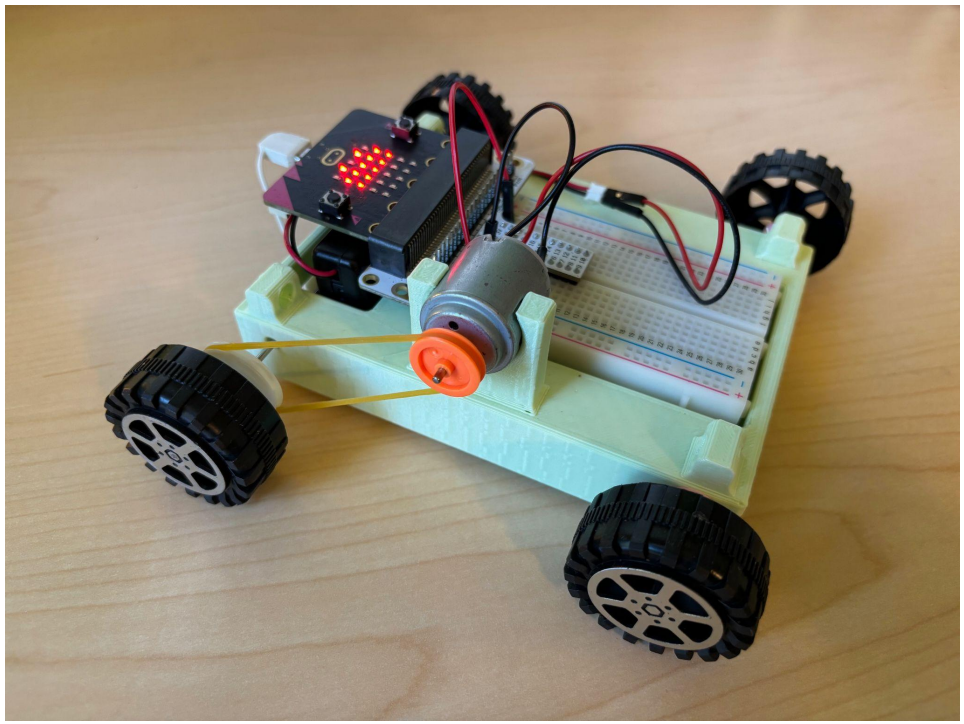


Time (seconds)	x	y	z
41.94	-500	288	-900
42.04	-304	268	-1008
42.14	-336	184	-956
42.24	-364	224	-908
42.34	4	124	-1060
42.44	252	332	-752
42.54	80	60	-1124

Finished EV Micro-Kart!

Congratulations, you have created an EV Micro-Kart with a variable speed motor, headlights & taillights, and an accelerometer!

- What have you learned about EVs?
- What questions do you have about EVs?
- Has your opinion changed about EVs?




Thank you!