NASA

TECHRISE

STUDENT CHALLENGE

Step 4: Plan Your **Suborbital-Spaceship**
Experiment Design
2025

Make an Experiment Design

Now that you've thought about your experiment idea(s), it's time to plan out how you would build it and make it work. There won't be a person on the TechRise flight to control your experiment, so you will need to use a microcontroller for automation.

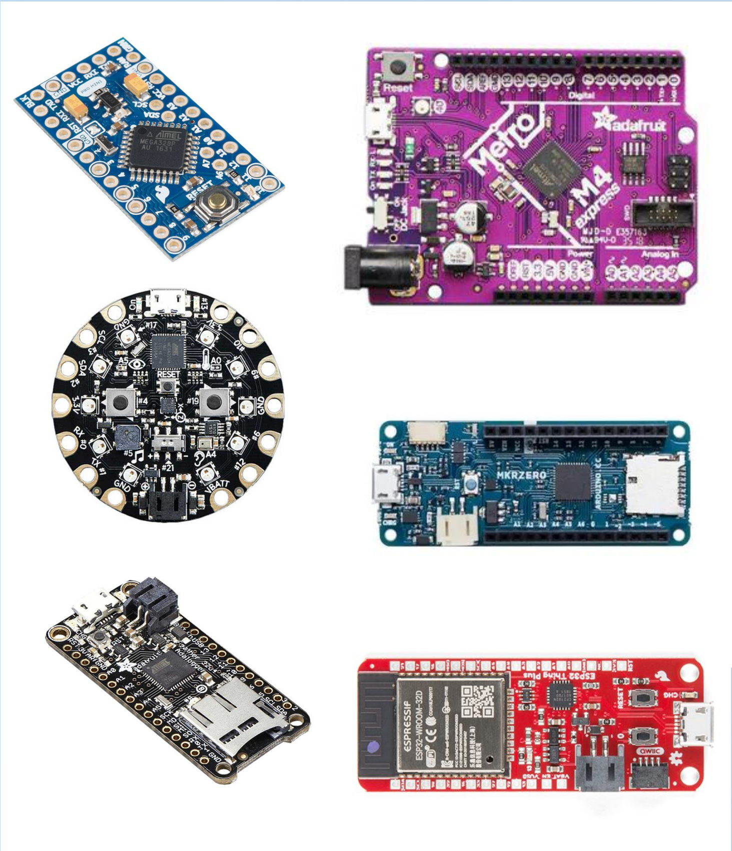
First, we will learn about microcontrollers.
Then, we will explore different hardware components/sensors.
Lastly, you will develop an experiment design that explains **HOW** your proposed experiment idea could function during flight.

What is a Microcontroller?

- A microcontroller is the “brain” of an experiment used to automate simple tasks by receiving data (input) and sending data (output).

- For example, a microcontroller could be programmed to receive data (input) from a temperature sensor and then tell a fan (output) to turn on if the temperature goes above 80 degrees F.

- Because microcontrollers can be programmed to automate specific tasks, scientists and engineers use them to remotely record data, control motors/pumps, or take images … whether in a lab, on a suborbital-spaceship, or on Mars!



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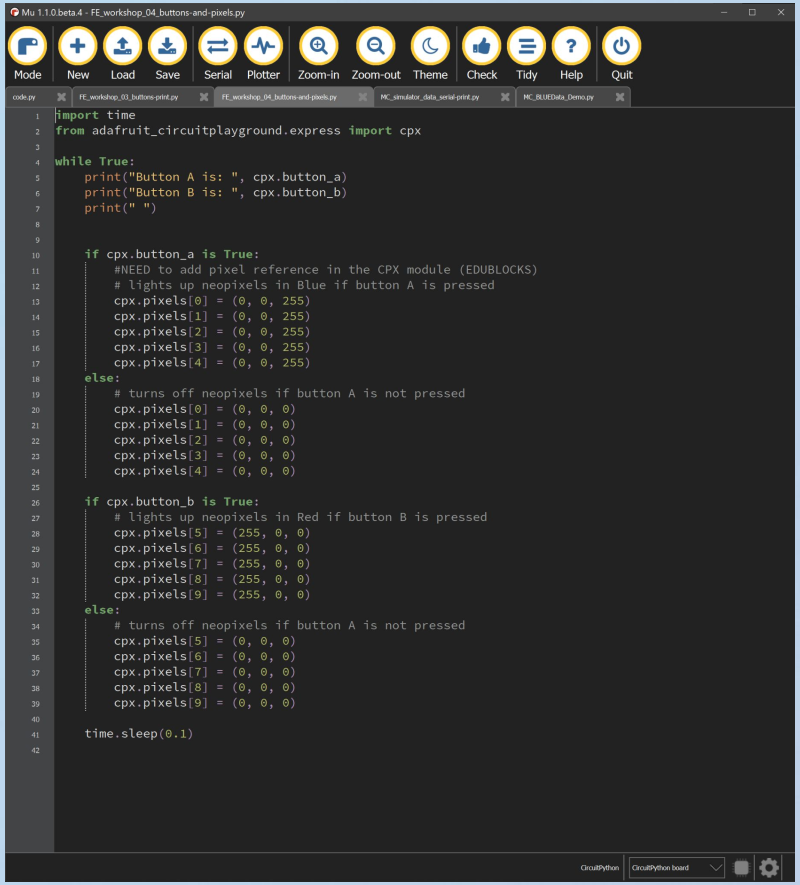
What is a Microcontroller?

- You can think of a microcontroller like a mini computer. They perform repetitive functions and can be programmed to interact with components (e.g., motors, sensors) to make your experiment work.

- You DO NOT need to include code in your proposal, nor do you need to know how to code to submit a NASA TechRise proposal, but rest assured that you will learn to code a microcontroller if selected as a winner!



Sample Experiment Design

- Now, let's look at a sample experiment and explore how to develop a design for your proposal.

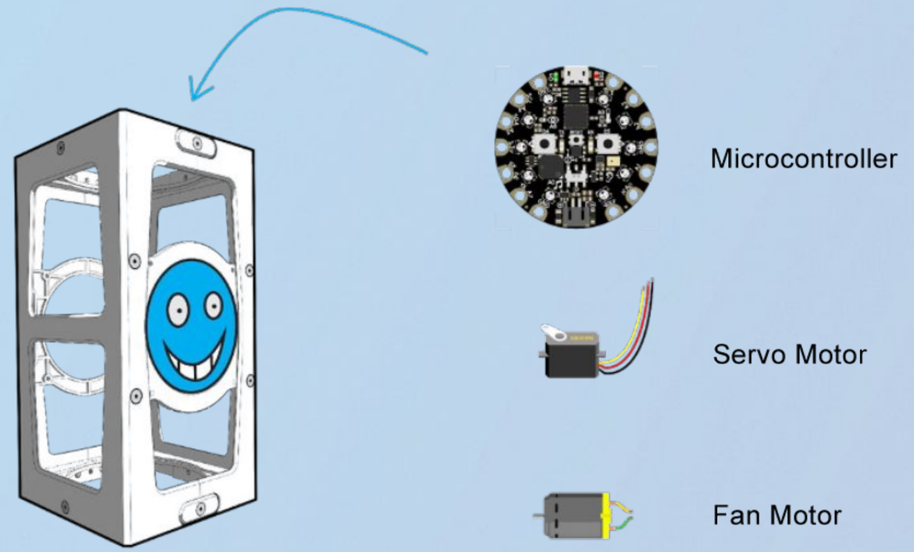
- Watch this sample TechRise experiment that was designed for a rocket flight. Although this year's flight is for a suborbital-spaceship, in this video you can see the size of a finished payload and how it is programmed to work in response to flight data.

Sample Experiment Design - Identify Components

The experiment you just watched used three main components:

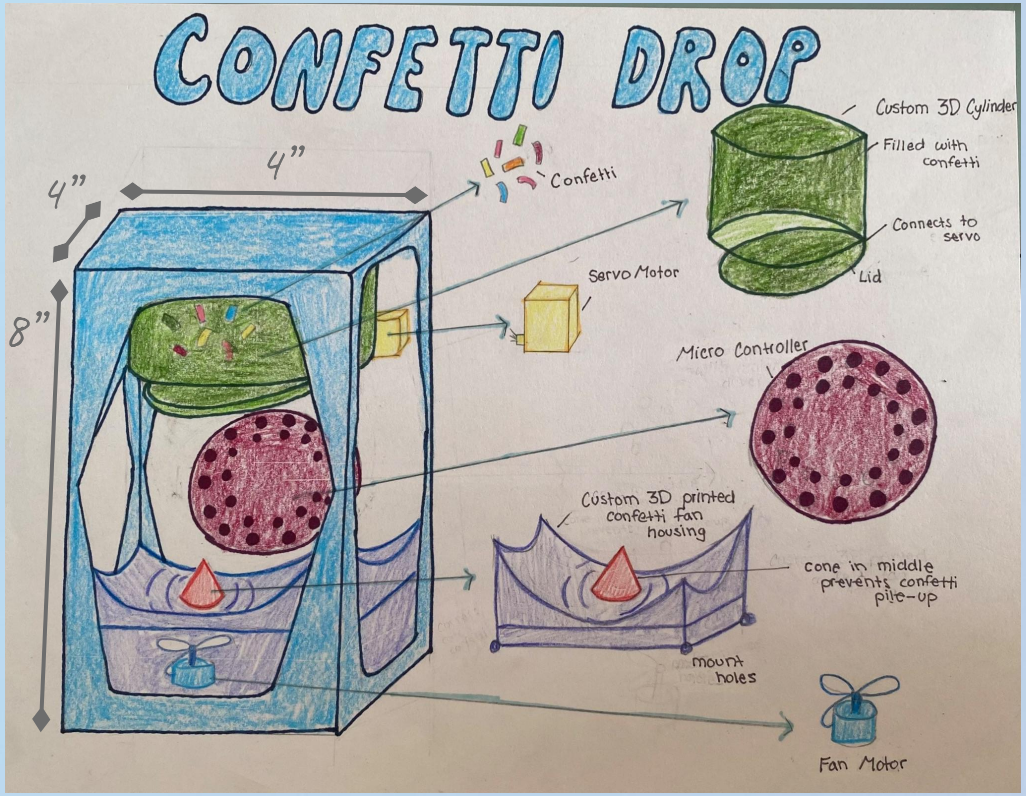
- A microcontroller that was programmed to release the confetti at a specific time
- A servo motor to release confetti
- A fan motor to blow the confetti

Mechanical Payload



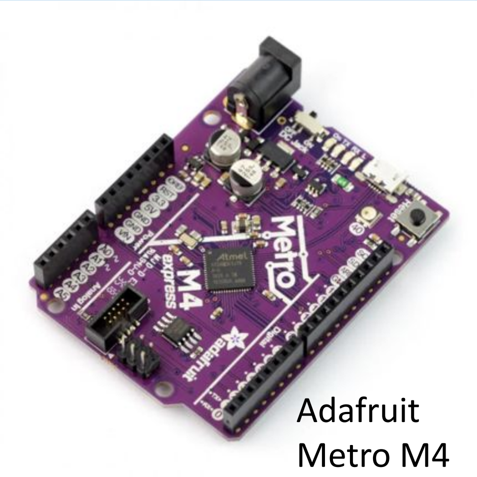
Sample Experiment Design - Draw how it will work

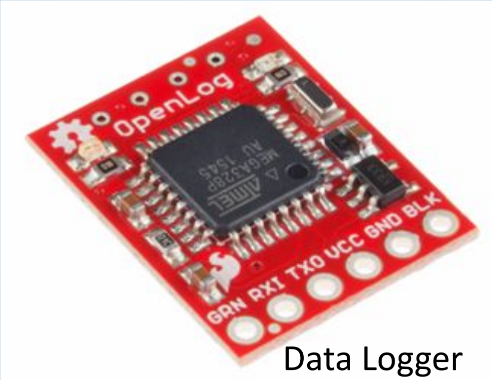
The sketch to the right shows a sample diagram of how the experiment is designed to work. Teams are encouraged to include a sketch or diagram of their proposed experiment in the HOW section of their proposal.



Explore Components: What will your experiment need?

In the following slides, we will review types of components that can be used with a microcontroller to build an experiment. As we review these different components, start thinking about what you may need to build your experiment idea.


Adafruit Metro M4


Data Logger


DC Motor in Servo Body

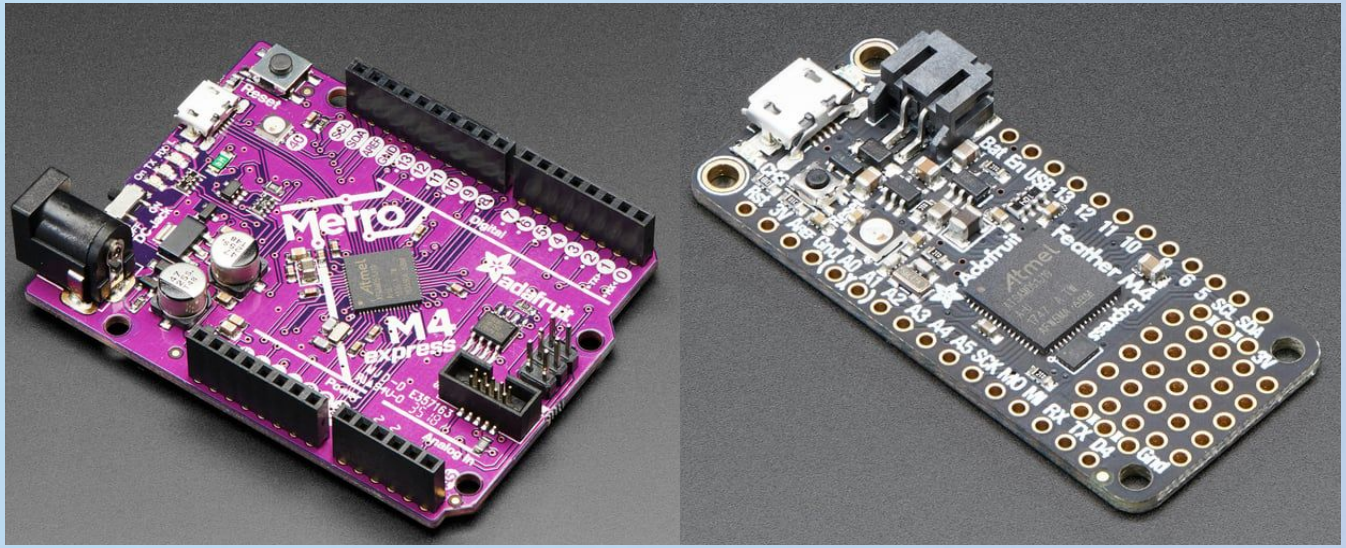

Solenoid


Dash Cam


Peristaltic pump

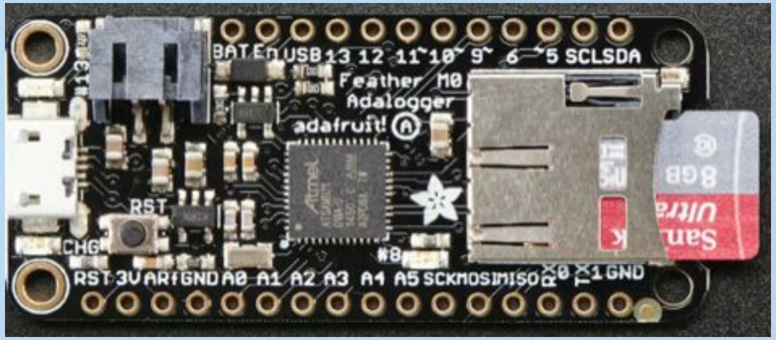
Which Microcontroller Should I Use?

TechRise winners will be provided a microcontroller, such as the Metro M4, as part of their introductory learning kit. This microcontroller can be programmed in CircuitPython or Arduino IDE (Integrated Development Environment).

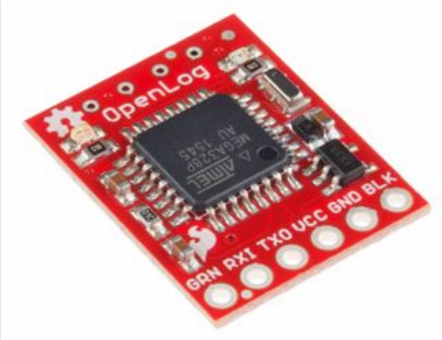


Data Capture

Do you need to record sensor data in your experiment? Like recording magnetism and acceleration data or saving camera images? Explore the data capture components on the worksheet like data loggers, microSD cards, and more.



Adafruit Feather M0 Adalogger



Data Logger
(has a microSD card soldered on)

MicroSD Breakout Board
(has a slot to hold a microSD card)

Adafruit SPI Flash SD Card
(has a microSD card soldered on)

Motion

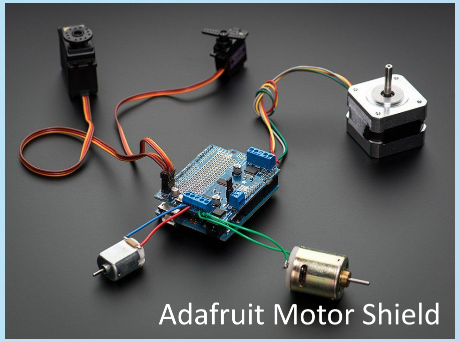
Do you need something to move, open, close, or spin in your experiment? What about actuating something to start in flight? Explore the motion components on the worksheet like motors, servos, solenoids, and pumps.


Peristaltic pump


Fan

A pump or fan allows you to move air between or within chambers

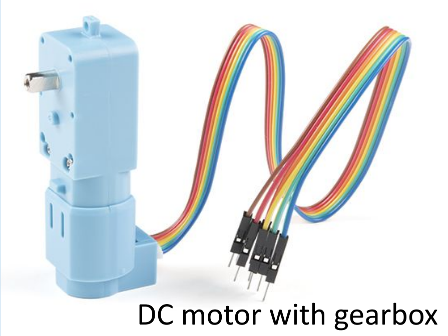

Sparkfun Motor Shield

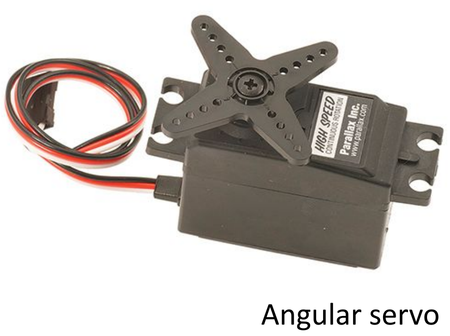

Adafruit Motor Shield

A motor shield allows you to control several motors


Solenoid

A solenoid uses magnets to push/pull a shaft


DC motor with gearbox


Angular servo

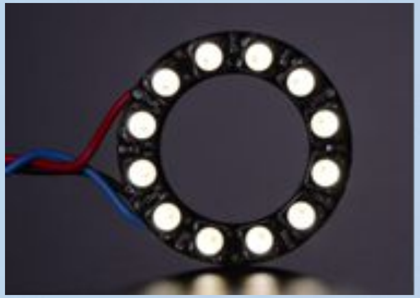

DC motor

DC motors, gearboxes, and servos allow for rotation with control over speed, torque, and/or angle

Imaging, Cameras, & Light Sources

What kind of cameras should be onboard your experiment? Cameras like the dash cam can take video of your experiment throughout the flight. But, you can use other cameras to see the invisible world inside your experiment, like infrared thermal imaging cameras. Check out the worksheet to explore possible cameras. It will be dark inside your payload during flight, so don't forget to include a light source!

Dash Cam *(records video and audio non-stop during flight)*



Neopixel Ring *(produces light when powered and controlled by a microcontroller)*

LED *(Light Emitting Diode: produces a small amount of light when wired to a circuit with a resistor)*

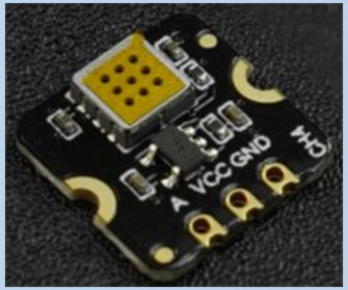
Adafruit Infrared Thermal Camera *(takes "images" showing a grid of the temperatures it sees)*

Environmental Sensors

Sensors are small but mighty devices that gather data and can tell you about the surrounding environment during flight. If your experiment aims to understand more about air quality, temperature, humidity, aerosols, or other environmental factors, you should browse these sensors on the explore components worksheet.

Ozone Gas Sensor

Air Quality VOC and CO2 Sensor
(Volatile Organic Compound and Carbon Dioxide)



Methane Sensor

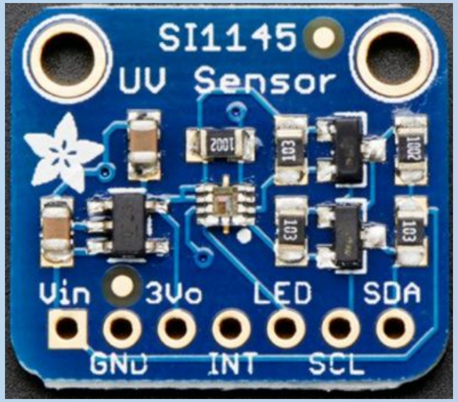
Air Quality Breakout Sensor
(measures particles in the air such as dust, pollen, or smoke)

Temperature, Humidity, Pressure and Gas Sensor

Light Sensors

Does your experiment need to measure light? Different intensities of light? Different wavelengths of light? Check out the light sensors section of the worksheet to explore which ones may be useful for your experiment.

UV Sensor



UV Sensor

Light Sensor

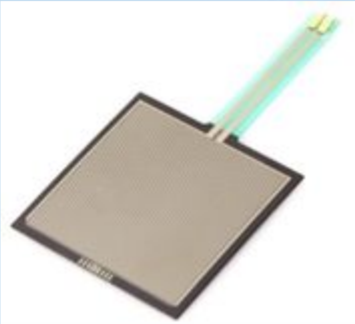
Light Spectrum Analyzer
(measures multiple colors and ranges of light)

Proximity, Light, RGB, and Gesture Sensor

Motion and Force Sensors

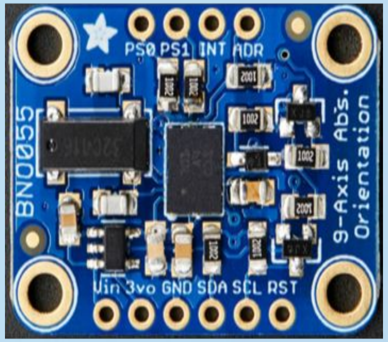
TechRise experiments will be on the move while traveling on the suborbital-spaceship. And, depending on your design, so could parts of your experiment, too! Look at the components worksheet to explore sensors that detect and measure force, motion, and vibration.

Ultrasonic Distance Sensor *(measures short distances using ultrasonic sound waves)*

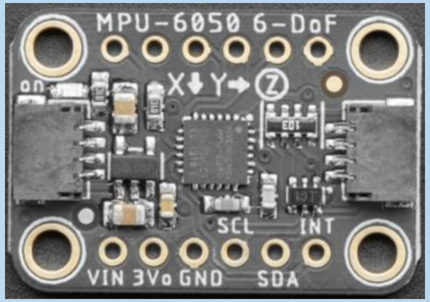


Force Sensitive Sensor *(measures small forces)*

Strain Gauge *(measures large forces, similar to a scale)*



IMU: Inertial Motion Unit *(measures rotation and orientation)*

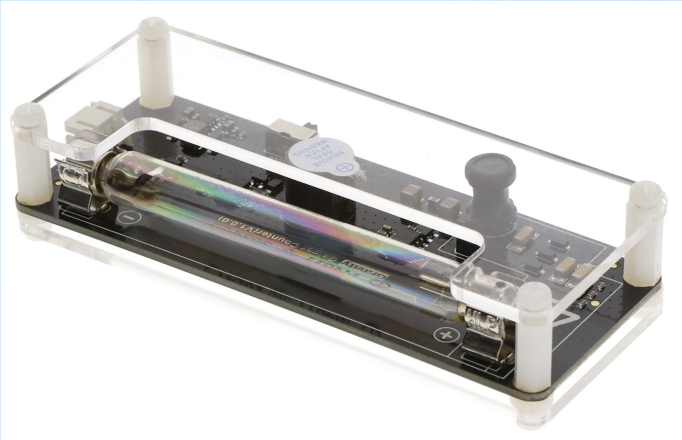


Gyro & Acceleration Sensor *(also known as an IMU)*

Infrared Beam Break Set *(sends a signal when beam is interrupted)*

Radiation and Magnetism

Understanding radiation is important to human health, particularly at high altitudes or in space. If your experiment aims to investigate radiation or magnetism, check out the worksheet to find a sensor that will work for your design.



Geiger Counter *(measures radiation)*

Magnetometer *(measures magnetic field)*

Accelerometer Magnetometer (measures magnetic field and acceleration)

YOU CHOOSE!

You are NOT required to use the components in the worksheet.

It is merely provided as a starting point. You may propose to use any components that your team needs to bring your experiment idea to life!

Explore Components Design Activity

Now it's time to design your experiment and develop the "HOW" for your proposal!

With your team, use the Explore Components Design Worksheet (Suborbital-Spaceship) to explore a list of possible components for your experiment and then create a sketch of your experiment design for the proposal.

Explore Components Design Worksheet

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<u>Explore Components Design Worksheet: Suborbital-Spaceship</u>
Pick one NASA TechRise experiment idea and plan your design.

Explore Components Design Activity Procedure

1. Now that you've brainstormed experiment ideas and understand the electrical components needed to build an experiment, choose one idea for your group, and plan the experiment's design.

2. Review the hardware component menu (below) and use the following questions as a guide to plan your experiment.

Choose one person in your group to record the answers to the following questions.

1. What is your experiment idea?

2. What is your hypothesis (educated guess about what you think will happen when your experiment is conducted)?

3. What data do you want to collect from your experiment to test your hypothesis?

4. What main components/hardware will you need to build your experiment? Use the hardware component menu below to help plan out the design for your experiment. Keep in mind you are welcome to use other components that you know of in the design and are not limited to only ones that you see in the list. Note: It is OK if you don't know how to use these components. You can think about the kinds of things these components do and how they could help you investigate your hypothesis.

5. Does your proposed experiment meet design guidelines? Remember that all experiments must fit in the 4" x 4" x 8" payload flight box and weigh less than 2.2 lbs. Experiment power is limited to the 9V and 1.0 A supplied by the suborbital-spaceship. Experiments cannot contain hazardous materials. Refer to the design guidelines for more details.

Share Your Ideas With Your Class