Explore Components Design Worksheet: High-Altitude Balloons

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 (i.e, 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?

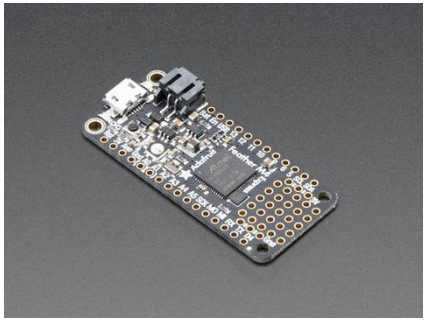
4. What main components/hardware will you need to build your experiment? Use the hardware component menu below to help plan out the design for your experiment. Keep in mind you are welcome to use other components that you know of in the design and are not limited to only ones that you see in the list. 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.

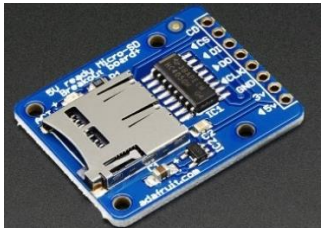
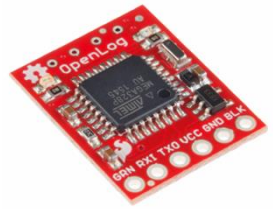
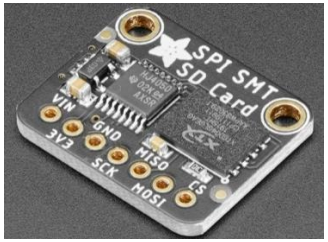
5. Does your proposed experiment meet design guidelines? Remember that all experiments must fit in the 4" x 4" x 8-in" payload flight box and weigh less than 2.2 lb. Experiment power is limited to the 9V and 1.5A supplied by the balloon. Experiments cannot contain hazardous materials. Refer to the design guidelines for more details.

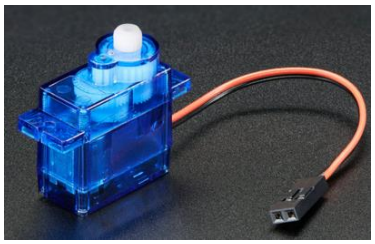
6. Follow the Design Guidelines (High-Altitude Balloon) and sketch a drawing or diagram of your experiment plan.

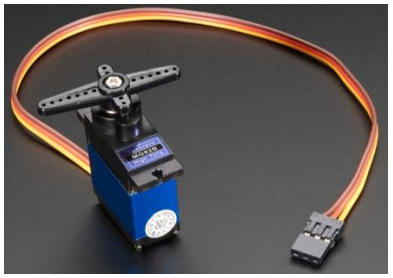
HARDWARE/COMPONENT MENU

This menu is meant to serve as a guide for what hardware types can be used for a TechRise Experiment. Teams are welcome to use other components not listed on this menu. If you have any questions about the hardware components listed, please do not hesitate to reach out to Future Engineers at support@futureengineers.org.

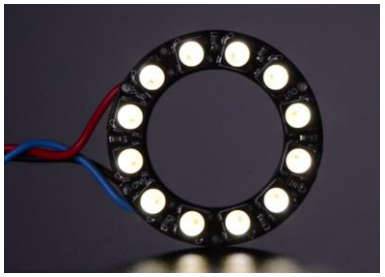
Component	Description	Reference Image	Possible Sources
Microcontroller	Microcontrollers are programmable chips that can be used as the "brains" of an experiment to automate simple tasks by receiving data (input) and sending data (output). You can think of a microcontroller almost like a mini computer. It performs repetitive functions and can be programmed to interact with the components below to build out your experiment. (A simple example could be a microcontroller programmed to receive data from a temperature sensor and to tell a fan motor to turn on if the temperature goes above a certain value.)	 Adafruit Metro M4  Adafruit Feather M4 Express	Metro M4 Source 1 Metro M4 Source 2 Metro M4 Source 3 Feather M4 Source 1 Feather M4 Source 2 Feather M4 Source 3

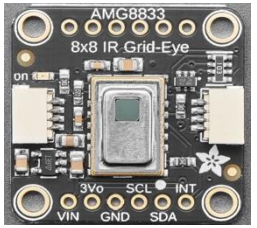
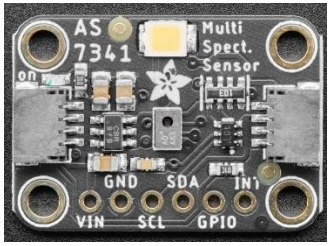
Data Capture	Experiments that are designed to collect data will require an additional device to store, or log, information as text so it can be retrieved and analyzed following a successful flight. SD and MicroSD card readers are well suited for this task. These external storage devices connect to a microcontroller allowing the controller to write data as text to files stored on the removable SD cards. Some development microcontrollers have built-in card readers, but most will need a second board, or “shield,” dedicated to data storage**.**	 Adafruit MicroSD Card Breakout Board  Data Logger  Adafruit SPI Flash SD Card - XTSD 512 MB	MicroSD Board Source 1 MicroSD Board Source 2 MicroSD Board Source 3 Open Log Source 1 Open Log Source 2 SPI Flash SD Card Source 1 SPI Flash SD Card Source 2 SPI Flash SD Card Source 3

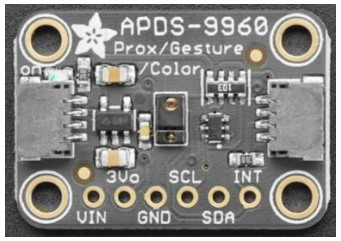
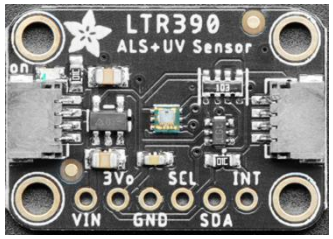
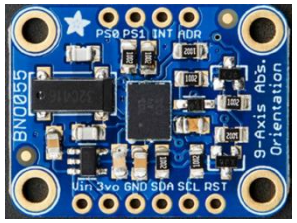
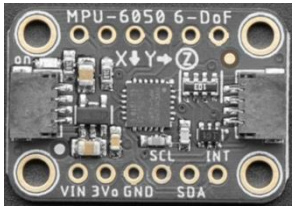
Motion Components			
DC Motors	Component that converts electricity into rotational mechanical energy. Motors can be selected to automate tasks using a certain speed or torque. Some motors need to be geared to provide higher torque at lower speeds. It is recommended that any DC motors be wired into a motor driver (see Electronic Hardware) rather than directly into the microcontroller to protect your microcontroller from current overdraw or backflow.	 DC Motor  Gearbox Motor  DC Motor in Servo Body  High Torque Motor with Gearbox	DC Motor Source 1 DC Motor Source 2 Gearbox Motor Source 1 Gearbox Motor Source 2 Gearbox Motor Source 3 DC Motor in Servo Body Source 1 DC Motor in Servo Body Source 2 High Torque Motor Source 1 High Torque Motor Source 2 High Torque Motor Source 3

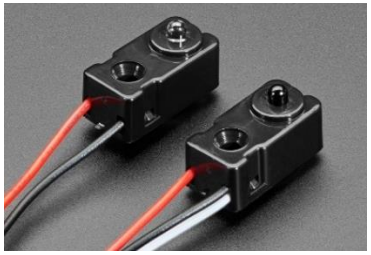
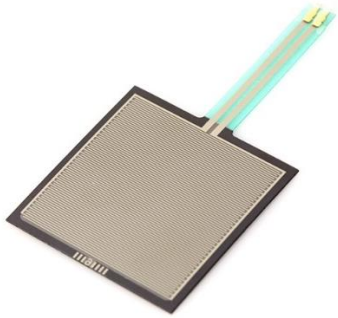
Servomotor (Servo)	A motor that can provide position control. The motor shaft can be moved to a specific angle or position swiftly and precisely. For example, you can program a servo to move from 0 degrees to 90 degrees at a specific moment during your experiment. Most servomotors cannot apply much force and are limited to a 180-degree range of motion, but they can be utilized as fast release mechanisms or lightweight actuators. Servomotors do not require a motor driver.	 Micro Servo High Powered  Continuous Rotation Micro Servo	Micro Servo High Powered Source 1 Micro Servo High Powered Source 2 Continuous Rotation Servo Source 1 Continuous Rotation Servo Source 2 Continuous Rotation Servo Source 3
Stepper Motors	Similar to a servo, a stepper is a type of motor that allows for precise control of rotation. Steppers are typically heavier than servos and require a motor driver to control; however, all steppers are capable of continuous rotation and usually have higher torque than servos. Steppers are commonly used in combination with screw gears to create linear motion.	 Mini Stepper Motor - NEMA-8 Size	Mini Stepper Motor Source 1 Mini Stepper Motor Source 2 Mini Stepper Motor Source 3
Solenoid	An electromagnetic device that can “push out” or “pull in.” Solenoids are an on-or-off mechanism that can operate very quickly to actuate linear movement. For example, solenoids are used in pinball machines to shoot away a ball quickly when it touches the bumper.	 Solenoid	Solenoid Source 1 Solenoid Source 2 Solenoid Source 3

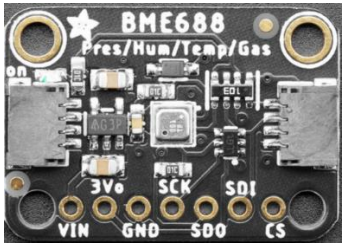
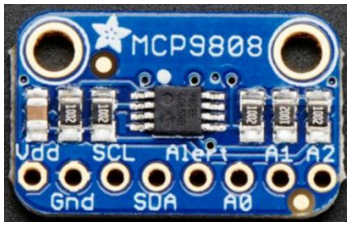
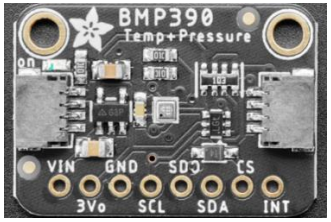
Pump	A pump is a device that moves liquids or gases by mechanical action – for example, water pumps or air pumps. The submersible pump only has a port for tubing on the outlet, while the peristaltic pump has tubing for the inlet and outlet. A peristaltic pump is recommended for any applications where the outlet is under pressure.	 Peristaltic Pump	Peristaltic Pump Source 1 Peristaltic Pump Source 2 Alternate Peristaltic Pump Source 1
Solenoid Valve	A solenoid valve uses a solenoid to open or close a valve. “Normally open” valves are open when not powered, and closed when power is supplied. “Normally closed” valves operate in reverse, opening when power is supplied and closing when it is removed. These valves are not suited to corrosive liquids.	 Solenoid Valve	Solenoid Valve Source 1 Solenoid Valve Source 2
Imaging, Cameras, and Light Sources			
Lights	Lights are recommended if you plan to take photos or videos of your experiment. Ambient lighting during the flight may fluctuate and image quality strongly relies on adequate lighting. Lighting an LED is a common first lesson in electronics. A 150-Ohm resistor is recommended on the positive (longer) lead of the LED; however, you may calculate the minimum necessary resistance if you would like the LED to be brighter. Neopixels do not require a resistor and instead can be wired	 LEDs	White LEDs Source 1 White LEDs Source 2 White LEDs Source 3

	directly into the microcontroller.	 Neopixel Ring	Neopixel Ring Source 1 Neopixel Ring Source 2 Neopixel Ring Source 3
Camera	A camera that takes photos or videos. Camera boards without an integrated microSD card slot (such as the Arducam) will require an external one and will occupy your microcontroller's processor while taking a video, rendering it incapable of any other actions. You can select an additional, smaller microcontroller dedicated to camera processing if necessary.	 Dash Cam  Arducam Mini Camera	Dash Cam Source 1 Arducam Mini Camera Source 1 Arducam Mini Camera Source 2 Arducam Mini Camera Source 3

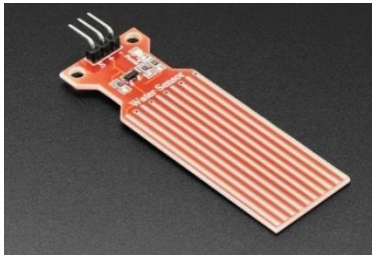
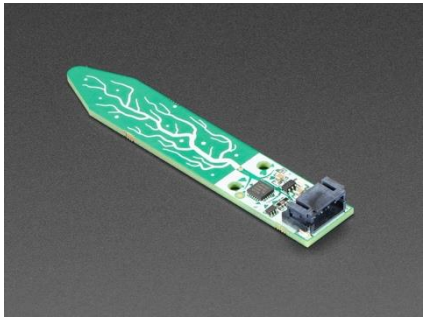
IR/Thermal Camera	An infrared camera that detects thermal (heat) energy. It senses an object's heat signature and creates an image of varying colors depending on how cold or hot an object is.	 Adafruit IR Thermal Camera Breakout 55 Deg  Adafruit IR Thermal Camera Breakout	Adafruit IR Camera 55 Deg Source 1 Adafruit IR Camera 55 Deg Source 2 Adafruit IR Camera 55 Deg Source 3 Adafruit IR Thermal Camera Breakout Source 1 Adafruit IR Thermal Camera Breakout Source 2
Light Sensors			
Visible Light Sensor	A sensor that detects light in the visible spectrum. Some are equipped with additional capabilities such as RGB value measurement or proximity readings.	 Light Sensor  Light Spectrum Analyzer	TSL 2591 Source 1 TSL 2591 Source 2 TSL 2591 Source 3 AS 7341 Source 1

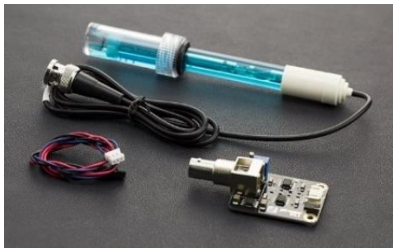
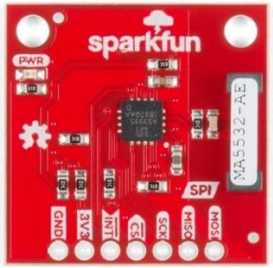
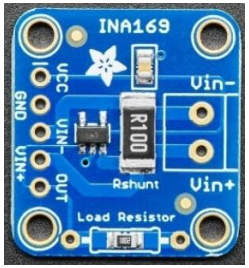
		 Proximity, Light, RGB and Gesture Sensor	APDS 9960 Source 1 APDS 9960 Source 2 APDS 9960 Source 3
UV Sensor	Sensor that measures ultraviolet rays.	 UV Light Sensor	UV Light Sensor Source 1
Motion and Force Sensors			
IMU, Orientation Sensor and Gyro	The inertial measurement unit can sense speed, direction, acceleration, force, angular velocity and more. The orientation sensor and gyro sensor measures the rotation of an object in three axes (x,y,z).	 IMU  Gyro & Acceleration Sensor	IMU Source 1 IMU Source 2 IMU Source 3 Gyro Source 1 Gyro Source 2 Gyro Source 3

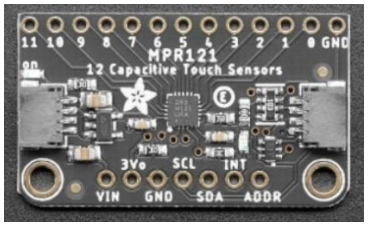
IR Beam Break Sensor Set	Infrared emitter and receiver set detects when the beam is broken. This set can be used as a “gate” to detect when something has crossed the invisible line produced by the emitter and receiver.	 IR Beam Break Set	IR Beam Break Set Source 1
Ultrasonic Distance Sensor	This sensor produces inaudible sound waves that are bounced off an object and reflected back to the sensor. It calculates the distance to the object based on the time it takes for the waves to be received.	 Ultrasonic Distance Sensor	Ultrasonic Distance Sensor Source 1
Force Sensors	Two common methods of force sensing are force sensitive resistors (FSR) and strain gauges. FSRs are an inexpensive and easy option but are fairly inaccurate. They are best used to detect changes in force but aren’t recommended to measure exact weights. Strain gauges can measure weight accurately; however, they are larger and more complicated to use. They require calibration and an analog-to-digital converter, like this one.	 Force Sensitive Resistor  Strain Gauge	Force Sensitive Resistor Source 1 Force Sensitive Resistor Source 2 Force Sensitive Resistor Source 3 Strain Gauge Source 1 Strain Gauge Source 2 Strain Gauge Source 3

Environmental Sensors			
Humidity Sensor	Sensor that measures humidity.	 Temperature, Humidity, Pressure and Gas Sensor	Humidity Sensor Source 1 Humidity Sensor Source 2 Humidity Sensor Source 3
Temperature Sensor	Sensor that measures temperature.	 Temperature Sensor	Temperature Sensor Source 1 Temperature Sensor Source 2
Pressure Sensor	Sensor that measures atmospheric pressure.	 Precision Barometric Pressure and Altimeter	Temp & Pressure Sensor Source 1 Temp & Pressure Sensor Source 2 Temp & Pressure Sensor Source 3
Particulate Monitor	An air quality monitor that measures pollutants in terms of particulate matter size. Can be used to detect particles in the air such as pollen, dust, soot, smoke, etc.	 Air Quality Breakout Sensor	Air Quality Sensor Source 1 Air Quality Sensor Source 2 Air Quality Sensor Source 3

Gas Sensors	Sensor that detects gas concentration in parts per million or parts per billion.	 Low Concentration Ozone Gas Sensor  Air Quality VOC and CO2 Sensor  Methane Sensor	Ozone Gas Sensor Source 1 Ozone Gas Sensor Source 2 VOC and CO2 Sensor Source 1 VOC and CO2 Sensor Source 2 VOC and CO2 Sensor Source 3 Methane Sensor Source 1 Methane Sensor Source 2
Radiation and Magnetism			
Radiation Sensor	Sensor that detects ionizing radiation.	 Geiger Counter Sensor	Geiger Counter Sensor Source 1 Geiger Counter Sensor Source 2

Magnetometer	Sensor that detects magnetic fields in 3 axes.	 Magnetometer	Magnetometer Source 1 Magnetometer Source 2
Water			
Water Sensor	Sensor that detects the presence of water. It can be used to detect water level with low amounts of accuracy.		Water Sensor Source 1 Water Sensor Source 2
Water Flow Rate Sensor	Small turbine that measures water flow rate.		Water Flow Rate Sensor Source 1 Water Flow Rate Sensor Source 2
Soil Moisture Sensor	Capacitive sensor that measures (unitless) moisture in soil.		Soil Moisture Sensor Source 1

pH Sensor	Sensor kit to measure pH of liquids.		pH Sensor Kit Source 1
Total Dissolved Solids (TDS) Sensor	Sensor kit to measure TDS of liquids.		TDS Sensor Source 1 TDS Sensor Source 2
Miscellaneous			
Lightning Detector	Detects lighting up to 131,234 ft (40 km) away.		Lightning Detector Source 1
Current Sensor	Measures current flow through the sensor board.		Current Sensor Source 1 Current Sensor Source 2

Air Velocity Sensor	Measures air velocity across the sensor board. NB: High-altitude balloons typically move *with* the air currents, meaning there may not be much air flow relative to the payload.		Air Velocity Sensor Source 1 Air Velocity Sensor Source 2
Capacitive Touch Sensor	Detects the presence of electrically conductive materials.		Capacitive Touch Sensor Source 1 Capacitive Touch Sensor Source 2
Other Useful Hardware			
Electronic Hardware			Prototyping(solderless) Breadboard Perma-proto(solderable) Breadboard Jumper Wires Slip Ring Motor Driver Resistors MicroSD Card & Reader Soldering Iron
Mechanical Hardware			Prototyping Mounting Hole Plates Springs Syringes One-way(check) valve Gears Angle Brackets

	Pulleys 3D Printer