2025- Brainstorm Activity Worksheet (High-Altitude Balloon)

Brainstorm possible balloon flight experiment ideas for the TechRise challenge.

Brainstorm Activity Procedure

1. Use the balloon brainstorm topics and questions below as a guide to come up with possible balloon flight experiment ideas.
2. All ideas are welcome, simple or complex.

Questions

1. What is special about the balloon's flight environment?

2. What brainstorming topic most interests your group? Read the brainstorming topic out loud and discuss what experiment ideas come to mind. Expand on your experiment ideas.

3. What science experiment would you like to conduct on a balloon?
    a. What do you want to study in the environment that the balloon provides?
    b. What kind of data would you like to collect?
    c. What is your hypothesis?
    d. Why is it important? How does it relate to NASA?

4. What technologies would you like to test on a balloon?
    a. What types of technologies do you find interesting?
    b. How do you think those technologies will function on the balloon flight, and why?

Write your ideas below:

BALLOON BRAINSTORM TOPICS

Compare Atmospheric Layers
Your experiment will ascend through two very different atmospheric layers: the troposphere and the stratosphere. What can you measure, compare, and learn between the troposphere and the stratosphere? What different sensors can you use to measure atmospheric pressure, air temperature, humidity, or light levels as your experiment travels through different atmospheric layers?

Ozone
Ozone is a naturally occurring gas found in both the troposphere and the stratosphere. The ozone layer provides protection from harmful UV radiation in the stratosphere but ozone found in the troposphere acts as a greenhouse gas, trapping heat in the atmosphere. The target float altitude of the balloon is right in the middle of the ozone layer, which is part of the stratosphere. What can you measure to understand the ozone layer better? How does the temperature change as you move through the ozone layer? How do UV radiation levels change? How important is ozone to our planet?

Greenhouse Gases
Understanding climate change is dependent on our understanding of greenhouse gases. What data can you gather to understand CO2 levels in our atmosphere? Or methane? How do greenhouse gases change with altitude and temperature? Is it the same or different as you fly over different areas? Why is it important to study greenhouse gases?

Temperature, Pressure, and Humidity
The air temperature, pressure, and humidity will change as the balloon ascends through the troposphere and stratosphere. Can you think of an experiment that measures or tests the air temperature and/or air pressure? What about humidity? Our atmosphere provides a superhighway for water vapor to move around the globe. Think about the water cycle and how water constantly evaporates, transpires, and moves upward to form clouds. For example, water vapor will surround your experiment as it ascends through the troposphere. But after the balloon flies above the clouds, it will enter the stratosphere, which is very dry and has little water vapor. How might you monitor or assess temperature, pressure, and/or humidity changes?

Radiation
NASA needs to understand ionizing radiation and its effects on living things as humans explore further and longer in space and near-space, or even high in our atmosphere on planes. Just as NASA flew a Moonikin around the Moon, how can you test the radiation levels a living thing or person may experience the closer they get to space? Or what kind of radiation shield can you invent and test during your flight?

Thermodynamics
Temperatures during flight can go as low as -80 degrees Fahrenheit and even colder in space. How can you use the extreme temperatures during flight to test ways to keep things warm on a long journey? From onboard heaters to innovative methods of insulation, there are many ways to study heat transfer and the impacts of cold climates on everything from people to electronics.

Air Quality
The air that we breathe is filled with small particles suspended in the atmosphere like dust, mold, microplastics, pollen, soot, smoke, and other fine substances. Particulate matter is typically separated into three classifications: coarse, fine, and ultrafine particles. Large particulate matter is generally filtered away in our nose and throat, but smaller particles can move into the cardiovascular system and cause health concerns. How can you use sensors to better understand the amount and size of particles in our atmosphere?

Materials Experiments
Materials react differently the farther away they get from the Earth's surface – from rubber to plastics to organic substrates like soil and seeds. Temperature can affect how much materials expand or contract. Ambient air pressure can affect how much an object inflates – like when a chip bag gets puffier at altitude. Radiation can affect how much materials degrade. What materials could you fly, test, and compare to objects here on Earth to study the effects of flight?

Moon and Mars Landing Systems
Did you know that the Perseverance Rover's Terrain Relative Navigation System was tested on a suborbital flight? The software used to avoid dangerous obstacles and identify safe landing zones was tested at altitude before it was used on Mars. What system or algorithm could you develop to identify key objects for a potential landing zone? How could it help NASA land spacecraft safely on the Moon or Mars?

Remote Sensing/Imaging of Earth
There is a world of visible and invisible imagery to explore during a balloon flight. From high-resolution cameras to thermal imaging, a picture is worth a thousand words. Cameras can be used to study the earth's surface – including doing vegetation mapping to look at vegetation health, crops, and agricultural areas. What image capture techniques can you test – from stereo/3D imaging to time-lapse to stitching together panoramas? And how can you compare your photos to historical archives to learn something new or see the impacts of climate change? During flight, your experiment will receive real-time GPS data. How can you use that data to help identify the locations that

you see during flight? Imaging is about both software and hardware. What mechanisms can you invent to help focus, zoom, or stabilize the camera during flight?

Lunar Dust Mitigation
Dust mitigation has been an issue for NASA since Apollo. Lunar regolith is easily disturbed and can coat everything with a fine layer of dust that sticks to surfaces like static cling. When astronauts were entering and exiting the lunar module, dust got everywhere – it clogged mechanisms, interfered with instruments, caused radiators to overheat, and even tore up their spacesuits. Can you come up with a solution to deal with the dust on the Moon? If so, what will it be, and how can you use the balloon flight to test it?

Living in Space – Air Quality on a Spacecraft
Air quality is a vital part of living in space. The recirculated air astronauts breathe in a spacecraft cabin is carefully monitored to make sure there are no pollutants that could potentially put them at risk. Think about ways you can monitor or improve air quality in a closed space. Can you utilize an existing air-quality technology, or will you invent your own? How can you then test those ideas on a balloon flight?

Earth's Magnetic Field Measurements
Magnetometers aboard high-altitude balloons can measure the Earth's magnetic field. Do you think you can map magnetic field fluctuations? Why do magnetic field fluctuations matter? What can they tell us about our planet?

You Choose!
There are so many experiments to consider! Maybe you want to investigate the types of research that have historically been done in the stratosphere – and push things further to learn more. Or what can you invent entirely new that can be tested on a high-altitude balloon flight? The stratosphere can be used to test and understand both our planet and our solar system, as well as create technologies that improve our knowledge and increase our capability to explore space.