Brainstorm Activity Worksheet (Rocket-Powered Lander)

Brainstorm possible rocket-powered lander flight experiment ideas for the TechRise challenge.

Brainstorm Activity Procedure

1. Use the rocket-powered lander brainstorming topics and questions below as a guide to come up with possible rocket-powered lander flight experiment ideas.
2. All ideas are welcome, simple or complex.

Questions

1. What is special about the rocket-powered lander 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. Would you like to conduct a science experiment on the rocket-powered lander?
    a. What do you want to study in the environment that the rocket-powered lander flight provides?
    b. What kind of data would you like to collect?
    c. What is your hypothesis?

4. Would you like to use the rocket-powered lander to test new technology?
    a. What new technology would you like to test?
    b. How do you think the new technology will react on the rocket-powered lander flight?

Write your ideas below:

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ROCKET-POWERED LANDER BRAINSTORM TOPICS

Imaging/Mapping the Lunar Surface Test Field (LSTF)

There is a world of imagery to explore during a rocket-powered lander flight. From high-resolution cameras to topographic mapping, a picture is worth a thousand words - especially on the Moon! What technologies can you test here on Earth that could be used to better understand the Moon's surface? What about crater mapping, looking for safe landing zones, or identifying dark or shadowed areas? What image capture techniques can you test – from stereo/3D imaging to infrared imaging to stitching together photos? How can GPS data be used to map where you've been or help identify important locations during flight?

Photos/Videos

Cameras (like the one on your phone) operate in the visible range of the light spectrum. They can be used to take photos and/or video to learn more about the simulated lunar surface. For example, individual images can be stitched together to create one large image that can be used as a map. What else can you do with photos or videos taken during flight?

Terrain Mapping

LIDAR, which stands for "Light Detection and Ranging," uses light beams to measure the distance to objects. A LIDAR sensor sends out a quick burst of light toward an object, which bounces back like an echo. Since we know that light travels at a constant speed, a LIDAR sensor can figure out how far away the object is based on the time it took for the light to return. With data from points all over the test field, could you create a 3D terrain map?

Charting the Course

How could you use GPS data during flight to learn something new? Maybe you want to map where your experiment traveled. Or record GPS coordinates at locations on the simulated lunar test field when your experiment finds something of interest.

Layer Data Together

Most technologies used today combine more than one type of data to increase accuracy or learn more information than what could be learned from each type of data individually. For example, obstacle avoidance software in cars often uses both visible light cameras and LIDAR. One way to accurately map the LSTF could be to combine the image data with GPS data. What could you learn by combining GPS data with your sensor data?

Object Detection

Our NASA TechRise team will plant secret objects on the simulated lunar surface test field prior to flight. The objects will be of different sizes, shapes, and colors and have different kinds of reflective surfaces. What experiment can you develop to help spot, identify, and categorize these objects during flight?

Studying the Physics of Rocket-Powered Lander Flights

What kind of physics are at work during a rocket-powered lander flight? Can you use sensors to measure the orientation, acceleration, or velocity of the lander during flight? Could you study the heat plume that's produced by the combustion of rocket fuel?

Thermodynamics

Thermodynamics is a set of rules that explains how heat (or energy) moves and changes between different things, like the air, water, or even rocket engines. It helps us understand how things heat up or cool down and how we can use that knowledge to build better machines like rockets. What can you learn by studying the shape, temperature, or motion of the rocket exhaust flames?

Inertial Measurement

The rocket-powered lander will hover and move around the lunar surface test field. Will it always be perfectly upright? Or could it tilt or spin during flight? Will it move faster in some portions of flight than others? Or change directions? To understand this, you can use an Inertial Measurement Unit, or IMU, to measure the acceleration and rotation of an object in three-dimensional space. This means it can tell you how fast the rocket is moving in the three primary directions - known as X, Y, and Z, as well as the rotation/angle/tilt of the rocket - known as Roll, Pitch, and Yaw. What could you learn about a rocket by studying its linear and rotational motion?

Measuring the Flight Environment

On the Moon, it will be important to understand the environmental conditions before, during, and after any exploration flight. What experiment can you test on a rocket-powered lander here on Earth to monitor environmental conditions? What different sensors can be used to measure environmental data, such as temperature or electromagnetic radiation? What can you measure, compare, and learn between take-off and landing?

Electromagnetic Radiation

Sometimes, when you watch a rocket launch on television, the video will go black and come back. This is because when the rocket burns fuel to achieve thrust, electromagnetic radiation is produced, and it can interfere with wireless communication. The electromagnetic spectrum contains all wireless

communication signals, as well as UV, IR, and visible light. For example, we can SEE one form of electromagnetic radiation that's produced when rocket fuel burns - that's visible light - but are there any other kinds of electromagnetic radiation that we can't see? What experiment can you develop to measure electromagnetic radiation on a rocket-powered vehicle?

Mitigating the Effects of the Vehicle

How are certain materials affected by a rocket flight? Are there any inventions you'd like to test under the physics of a rocket flight? Rocket flights can be a hot, bumpy ride, so NASA scientists are always looking for new ways to ensure payload safety, whether it be insulating from the heat of the thrusters, dampening the vibrations of launch, or absorbing the shock of landing.

Thermal

Temperature can affect how much materials expand, contract, or even weaken. What materials could you fly, test, and compare to make sure that the items in your experiment are safe and protected during flight next to a hot rocket plume?

Vibrations/Shock

Rocket flights can be a bumpy ride and rocket-powered landers are no exception! Could you build a device to reduce the effects of vibrations/shock on the cargo inside your experiment during launch and landing? Can you develop a way to stabilize your camera during flight to reduce jitter - whether via mechanical shock absorption or by using image-stabilization software?

Rotation/Movement

During flight, the rocket-powered lander may rotate or tilt. Can you develop a way for your camera to always point in the same direction regardless of the vehicle's motion? Or maybe you can develop a way for your camera to stay focused on one spot as the lander traverses the course?

You Choose!

There are so many experiments to consider! Maybe you want to investigate the types of research that have historically been done on lunar surface mapping – and push things further to learn more. Or what can you invent entirely new that can be tested on a rocket-powered lander flight? The rocket flight environment can be used to test and understand the effects of both rocket acceleration and thermodynamics, as well as create technologies that improve our knowledge and increase our capability to explore space.