Amber Agee-DeHart

Airborne Science Fact Sheets – *For Educator Use Only*

There is quite a bit to learn when it comes to rocket or balloon science. And we understand you don't have the time to do extensive research in preparation to facilitate the program for students.

Therefore, we have provided Fact Sheets to provide you with a solid foundation of knowledge about the sounding rocket and the high altitude, zero-pressure scientific balloon. We hope this will help make feel you more comfortable with the content.

Introduction:

There are two flight opportunities on which to launch experiments - a sounding rocket and a high-altitude scientific balloon. These airborne platforms are vehicles that launch high into space or near space and carry instruments to collect measurements or conduct experiments.

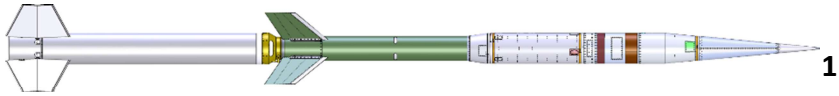
Sounding Rocket:

The sounding rocket is a two-stage, Terrier Improved-Orion rocket that launches into space from NASA's Wallops Flight Facility on Wallops Island, Virginia in the United States. The rocket launches to the east over the Atlantic Ocean where it is recovered up to 70 kilometers (50 miles/43 nautical miles) off the coast after flight. The trajectory (path followed by a projectile) is a parabolic, suborbital path. It goes up in an arc and returns to Earth. It does not orbit the Earth.

Rocket Motors and Flight Duration:

Each stage contains a motor. The first stage houses the Terrier MK motor and is located at the bottom of the rocket. This stage contains a vast amount of fuel that burns very quickly to launch off the pad and into the atmosphere. Once the fuel is completely consumed and the stage burns out, this first motor drops off the rocket in approximately 6.2 seconds after launch. The second stage houses the Improved Orion motor and burns fuel more slowly (25.4 second burn time)and gets the rocket into space. The total flight time is six to seven minutes in length.

Terrier Improved-Orion
Sounding Rocket



Cubes in Space™

ingenuity taking flight™

Sounding Rocket Fact Sheets – *For Educator Use Only*

Rocket dimensions:

The rocket is approximately 11.8 meters (~39 feet) in height. The diameter of the first stage motor is ~46 cm (18 inches), and the diameter of the second stage motor is ~36 cm (14 inches). The total vehicle (rocket) mass is ~1588 kg (~3500 pounds)and can carry with~299kg(~660pounds) of mass.

Experimental Payloads:

Instruments and anything else needed to support the experiment (e.g. circuits, wires, screws, etc.) are called a payload. The Cubes in Space payload, consisting of 80 student experiments, will be located in the nosecone of the rocket. The student experiments must be completely contained within a 4X4X4 cm plastic cube with a required total mass = 64grams+/-2grams. There are 5 layers of 16 cubes in the carrier contained in the cylindrical payload canister.

The canister is 23.6 cm in diameter with a height of 24.13 cm. The students' experiments must NOT contain liquids, lasers, radiation sources, explosives, communication devices, pressurized items > 30 psi, chemicals causing combustion during flight, live animals or insects, or organic material that decomposes to a liquid or slime (e.g. mushrooms, cucumbers). Experiments MUST weigh 64 grams +/- 2 grams and receive approval for all non-hazardous chemicals, micro/macro organisms such as larvae or bacteria, and gels. **Experiments must be designed to be opened and inspected prior to launch.**

Launch and Flight Conditions:

At launch, payloads experience 20-25g's of downward force. During flight the rocket experiences 7 g's of centripetal, spinning force. When the parachute deploys upon descent, the rocket experiences -10 g's of (yanking) upward force. The payloads will also experience violent shaking during the vibration test prior to the flight and during the flight. This shaking is worse than what is experienced by a paint mixer machine at a hardware store. These forces are not easily replicated in a lab or classroom environment.

The rocket flight is suited well for engineering design experiments (easier) and scientific research (definitely doable but more challenging).

Cubes in Space™

ingenuity taking flight™

Sounding Rocket Fact Sheets – *For Educator Use Only*

Launch and Flight Conditions: (cont.)

Payloads inside the rocket canister and nosecone remain at a constant pressure of 1 atmosphere (1 atm) which is equivalent to standard air pressure at sea level. 1013.25 millibars, 760 mm of mercury, 29.92 inches of mercury, 101.325 kilopascals, 14.7 pounds per square inch (psi).

The temperature range is between 20℃ to 55℃. The highest temperatures are experienced during flight in the nosecone and while awaiting recovery. The high temperature is due to friction from traveling through the atmosphere at such high velocity. The rocket experiences two to three minutes of microgravity during spaceflight. It is exposed to high levels of radiation in space.

Launch Location and Schedule The rocket launch occurs around the third or fourth Thursday of June between 06:00-08:00 (-04:00 GMT) Eastern Daylight Time. The rocket recovery takes between three to six hours depending on the distance traveled and wave height in the Atlantic Ocean. Deintegration takes place several hours after the payloads are returned to NASA's Wallops Flight Facility. Payloads are returned to educators up to several weeks after spaceflight

Launch Risks:

There is a small risk of mission failure due to not being able to launch because of storms or high winds or from fishing vessels entering and not leaving the launch range in the Atlantic Ocean. If the rocket experiences catastrophic failure, meaning the rocket explodes or was detonated during any stage of the launch or flight, it will not be possible to recover the experiments. If either scenario occurs, we will fly payloads on the next flight made available to Cubes in Space.

Conditions to Exploit for Experiment:

- Microgravity
- >20g'sdownward force
- >10g'supwardforce
- >7g'sofspinningforce
- Exposure to ionosphere

To Remember:

- Air pressure does NOT change during the flight. It is a constant 1atm.
- Temperature reaches a maximum of 55 ℃ for up to 2-3 hours during flight and recover.

Cubes in Space™

ingenuity taking flight™

Scientific Balloon Fact Sheets – *For Educator Use Only*

Zero-Pressure High Altitude/Stratospheric Scientific Balloon:

The balloon launches from the NASA Columbia Scientific Balloon Facility in Ft. Sumner, New Mexico in the United States in late August or early September. These balloons are part of the suborbital spaceflight program and serve as carriers for science instruments in similar ways as orbiting satellites or the International Space Station but at a much lower cost. The Cubes in Space experiments are a passive (non-powered), secondary (piggyback) payload on NASA's Test Flight mission with the Balloon Program Office.

Flight Conditions:

The balloon travels to a near space environment at the highest level of the stratosphere with a float altitude between 29.2-38.7 kilometers (96-127 kilofeet). The conditions this high in the atmosphere are very similar to the Martian atmosphere. The lowest temperature is around -50℃, and the lowest air temperature is ~0.01 atm. There is a minimal amount of breathable oxygen at the highest level of the stratosphere. And at that elevation, the balloon and payloads experience a high level of radiation. The flight can be between 3-24 hours in duration. The balloon is recovered somewhere in Arizona, New Mexico or western Texas.

There will be up to 120 student experiments mounted into a case with a clear "window" facing outward, away from the side of the gondola. The payloads will have a field of view of Earth and space. The same constraints as the rocket flight apply to the students' experiments except there is NO minimum or maximum limit to the payload mass.

Balloon Structure and Operations:

The balloon is made of thin polyethylene plastic (0.02 mm or 0.8 mil) inflated with 1.12 million cubic meters of helium and is 121 meters high and 140 meters wide upon inflation. The balloon can lift a total mass of 3600 kilograms to an altitude of 36 kilometers (~120,000 feet) or higher if the payload is lighter. To begin its descent, the balloon is vented meaning the helium is slowly released. It does not "pop" to begin its descent like weather or small scientific balloons.

Cubes in Space™

ingenuity taking flight™

Scientific Balloon Fact Sheets – *For Educator Use Only*

Launch Risks:

Risks include having the launch delayed for days or even weeks while waiting for acceptable weather conditions. Should the gondola and balloon land in a canyon or an area that is too dangerous for the NASA CSBF crew to access, there is a small risk that the payloads may not be recovered.

Conditions to Exploit:

- Fluctuating temperatures with flight through atmospheric layers and exposure to sunlight.
- Extremely low temperatures -50℃
- High levels of radiation
- Extremely low atmospheric pressure
- Changing/fluctuating atmospheric pressure
- Slow ascent to near space • Field of view towards space and Earth