

Battle of the Rockets TM ***Competition*** ***2017***



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Introduction

The Battle of the Rockets™ is a program of the Federation of Galaxy Explorers. The program is a series of competitive events focusing on the engineering design cycle. The events within the competition are designed to inspire student's interest in engineering and science with an exciting hands-on competition. The competition provides multiple levels of difficulty of engineering design challenges. These challenges are meant to continuously increase as the competitor's skill level grows. Each year, Galaxy Explorers will introduce new and more complex event challenges for the competition.

Dates

Registration for the competition is due by Oct 30, 2016.
The launch will be held in April 2017 and will be for two days.

The Competition

The competition comprises multiple events. Each event has unique challenges and complexities. The events are judged separately.

Contact Information

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Event 1: Planetary Lander, Advanced

This event is for University and advanced high school teams.

Design a rocket and planetary lander to launch to a minimum of 1000 feet and deploy the planetary lander. The planetary lander must be deployed from the rocket at no less than 600 feet from the ground after the rocket reaches 1000 feet. The planetary lander must be fully contained in the rocket before being deployed. Once deployed, the planetary lander must return to the ground safely. Once landed, time starts for the planetary lander to perform the different levels of operations for no less than 15 minutes. Telemetry must be transmitted at no faster than 1 Hz rate.

A ground station must be developed to collect and display the telemetry received. Extra points are earned if the data is plotted in real time. If images are to be acquired from the lander, each image must be displayed on the ground station. Each image captured must be displayed. Newer images can replace older images on the ground station display.

Lander Requirements

Req #	Requirement
1	Lander cannot weigh more than 1 Kg.
2	Lander must be contained completely inside the rocket during launch.
3	Lander must operate autonomously.
4	Lander cannot be controlled in any way by any remote method except for camera operations after it has landed and uprighted itself.
5	The lander must be secured so no part of the lander free falls.
6	No pyrotechnics are allowed in the planetary lander.
7	No Lithium Polymer batteries are permitted.
8	Must use one XBEE radio. Frequency can be 900 MHz or 2.4 GHz.
9	The XBEE radio cannot broadcast. The PAN/NET ID must be set to the team number.
10	All telemetry and image data must be transmitted using the same XBEE radio. Multiple radios are not allowed.
11	Telemetry shall be transmitted at no more than once per second.

Ground Station Requirements

Req#	Requirement
1	Ground station must display telemetry in real time. Plotting data gets more points.
2	Ground station must display any images received. One image can be displayed at a time.
3	Ground station must operate on battery power only.
4	The ground station must be portable so it can be moved to the ground station location at the field along the flight line.
5	Ground station antenna must be hand held.
6	The ground station must count the number of telemetry packets received.

Rocket Requirements

Req #	Requirement
1	The rocket motor must not exceed 1280 N-s.
2	The rocket must reach at least 1000 feet.
3	The rocket must use a motor retainer. Friction fit is not allowed.
4	All common rules must be followed.

Documentation Requirements:

Teams must submit a preliminary design review document and a critical design review document.

PDRs are due by December 1.

CDRs are due by February 1.

Templates will be provided for both PDR and CDR. Design review will be scheduled after each submission date. Teams will present via teleconference.

Judging and Scoring:

Before launching the planetary lander, the planetary lander must be shown to the judges and the upright position identified. Once the upright position has been identified and recorded, the team may launch their planetary lander. Once the planetary lander has landed, a field judge will locate the lander and determine if the lander is in the upright position. The lander has 5 minutes from landing to get into the upright position. The lander must not be touched by any team members until the judge has given approval. Once 15 minutes has passed, the team may retrieve the lander.

Before launch, teams must secure a judge to be at the ground station. The judge will review the ground station and indicate when ready for launch. The team must also determine when they are ready for launch. One member of the team must be designated the mission control officer and must be positioned at the launch control officer and verify with their team they are ready for launch. The rocket will not be launched until the mission control officer gives word to launch.

Scoring

Teams will receive a score for each level successfully completed. Certain levels require previous levels and must be completed in order to gain current level points.

Level	Score	Function
0	50	Safely landing, no free fall or tangled chute.
1	100	Autonomously uprights itself within 5 minutes and sends telemetry indicating it has uprighted. Must be within 30 degrees of vertical. You define the upright position.
2	1 per packet	Autonomously transmits basic telemetry: temperature, humidity, light intensity, battery voltage
3	1 per packet	GPS Telemetry added to basic telemetry (Level 0 and 2 must be completed.)
4	10 per image	Take still picture and transmit image to ground station with a minimum resolution of 640x480 in color (level 0, 1, 2 must be completed)
5	15 per image	Remotely point camera, take still picture and transmit image with a minimum resolution of 640x480 and in color (level 0, 1, 2 must be completed)
6	300	Generate a 360 panoramic image of the horizon with a minimum of 640x480 resolution and in color (levels 0, 1, 2 must be completed)
7	100	All solar powered operations (no batteries but supercaps allowed. Levels 0, 1, 2 must be included)
NA	25	All Sensor data is plotted in real time using engineering/scientific units.

Event 2: Planetary Lander, Kit

This event is for high school teams only.

Teams must use a FoGE Planetary Lander Kit for the competition. Teams must assemble and program the kit to be launched from a rocket to an altitude of 1000 feet minimum, be deployed from the rocket, and safely land. After landing, the Planetary Lander kit must open and upright itself and start collecting sensor data and transmit it to a ground station. All operations are to be completely autonomous.

Teams must integrate two additional sensors to the kit in addition to the sensors included. The sensors must be unique and not duplicate any other sensors. Telemetry must be transmitted once every one second.

Teams must design and build a rocket to launch the planetary lander to a minimum of 1000 feet. The planetary lander must be deployed at an altitude no less than 600 feet.

Teams must develop ground station software to collect all sensor data and display it in real time.

Lander Requirements

Req #	Requirement
1	FoGE Kit must be used.
2	A minimum of two unique sensors must be added.
3	Telemetry must be transmitted at least once every four seconds.
4	Planetary lander must operate for 30 minutes.
5	No lithium polymer batteries permitted.
6	No pyrotechnics are allowed in the planetary lander.
7	Telemetry must be transmitted at no more than 1 second interval.

Ground Station Requirements

Req #	Requirement
1	Ground station must display telemetry being received in real time. Plotting data gets more points.
2	Ground station must display any images received. One image can be displayed at a time.
3	Ground station must operate on battery power only.
4	The ground station must be portable so it can be moved to the ground station location at the field.
5	Ground station antenna must be hand held.

Rocket requirements

Req #	Requirement
1	The rocket motor cannot exceed 640 N-s.
2	The rocket must reach at least 1000 feet.
3	The rocket must use a motor retainer. Friction fit is not allowed.
4	All common rules must be followed.

Documentation Requirements:

Teams must submit a preliminary design review document and a critical design review document.

PDRs are due by December 1.

CDRs are due by February 1.

Templates will be provided for both PDR and CDR. Design review will be scheduled after each submission date. Teams will present via teleconference.

Judging and Scoring:

Before launch, teams must secure a judge to be at the ground station. The judge will review the ground station and indicate when ready for launch. The team must also determine when they are ready for launch. One member of the team must be designated the mission control officer and must be

positioned at the launch control officer and verify with their team they are ready for launch. The rocket will not be launched until the mission control officer gives word to launch.

Once the planetary lander has landed, a field judge will locate the lander and determine if the lander is in the upright position. The lander has 5 minutes from landing to get into the upright position. The lander must not be touched by any team members until the judge has given approval. Once 30 minutes has passed, the team may retrieve the lander.

Scoring:

Level	Points	Function
0	50	Lands safely
1	200	Uprights itself
2	1 per packet	Telemetry received and displayed
3	1 per packet	Two additional sensor data received and displayed
4	50	Operates half hour
5	100	Camera is one of the extra sensors and an image is transmitted through the existing radio. Image is displayed on ground station display.
NA	25	All telemetry is plotted in real time on the ground station display.

Kit purchasing information

Kits can be purchased from this site: <http://pratt-hobbies.com/proddetail.asp?prod=LANDER-1>

Event 3: Target Altitude

Design and build a rocket to fly on any commercial certified G level rocket motor to an altitude of 1213 feet. The rocket closest to 1213 feet wins. The rocket must safely recover and be in condition to be flown again. The team must perform two successful flights meeting all the requirements out of three attempts. Two attempts must meet the requirements or be disqualified. The altitude difference from 1213 is used as the score. The scores from the two successful attempts are added together. The lowest score wins.

Requirements:

Item	Requirement
1	Two successful flights must be completed out of three attempts.
2	Any commercial certified G motor is allowed.
3	Any commercial altimeter may be used.

Judging and Scoring

The scoring is the absolute difference between the altimeter reading and 1213 feet. The two best attempt scores will be summed and be the final score. Lowest score wins.

After teams complete a qualification flight attempt, the team must take their rocket with the altimeter to the judges tent to record the altitude. Do not turn off the altimeter until after the altitude has been recorded. The altitude must be recorded at the judges tent.

Application

Teams must submit an application form and identify each event to be attempted. The application form requires student information and a signed release form. No information will be released or sold. All applications are to be destroyed after the competition. The information requested are for administrative and insurance purposes only. The application for each event is \$50 and is nonrefundable. Teams can compete in more than one event and must qualify for each event.

Team Requirements

Teams shall have at minimum 2 members and no more than 10 members. Teams can consist of university, college, or trade school students currently enrolled in a university, college, community college, high school, or trade school. Each team must have a faculty advisor assigned to the team. The faculty advisor may support multiple teams.

At least one team member must have a membership in Tripoli or NAR to use high power rocket motors of H or greater.

Only team members can work on any aspect of the competition including the design, simulation, construction, repair, and launching. Adults, companies, and any non-team members cannot help.

Safety Review for Rockets

Teams are to submit a safety document with all sections filled out. The safety document will be provided when teams sign up.

Teams are to complete one test flight and submit a flight document before the competition. Due to the complexity of some of the rockets, test flights must be completed before the competition.

Test flight information can be submitted electronically via email. An email address will be provided.

Common Rules for All Events

Item	Rule
1	All competitors must follow the Tripoli High Power Safety Code. The code can be found on the Tripoli website. www.tripoli.org
2	The rocket must have been flown before. No first flight rockets are allowed.
3	All rockets shall use a single motor: no clusters or staging allowed.
4	The airframe, fins, nose cone, bulk plates, centering rings, and motor mount cannot be made of any metals.
5	Metal fasteners and small metal components are allowed.
6	Composite materials are allowed.
7	Launch lugs are not allowed.
8	Competitor can provide their own launch pad and controller.
9	A positive motor retention is required. Motor retention must pass RSO approval before the flight will be allowed.
10	Friction fit of motors are not allowed.
11	No modifications are allowed to any of the currently certified commercial motors. Manufacturers that allow modifications to the delay charge as part of standard assembly is allowed.
12	Only currently certified NAR/Tripoli commercial motors are allowed.
13	Thrust to weight ratio must be at least 5:1.
14	Any of the commercially available altimeter are allowed.
15	Electronic deployment devices are allowed.

16	Electronic deployment devices must be disarmed until the rocket is placed on the launch pad. Giant Leap Rocketry Slimshot and EFC are allowed to be configured as in the directions provided by the manufacturer.
17	Recovery aids such as radio beacons/trackers and audible beacons are allowed.
18	Maximum descent rate must not exceed 20 feet/sec.
19	A recovery system is required so that the rocket lands and is immediately flyable without the need for any repairs or alterations. Rockets not meeting this definition will be disqualified.
20	Any structural part of the rocket recovery system, or motor that free falls will result in a disqualification. Pop off rail guides are considered part of the ground support equipment. Any components that are supposed to be released or discarded for launch purposes are allowed. The competitor must specify what gets released or discarded for launch purposes before the launch.
21	The word of the safety committee and range safety officer is final. The safety team and/or RSO are the ultimate judges in determining a safe or unsafe flight.
22	Rockets are not to exceed 15,000 feet due to waiver limits. To be safe
23	Up to three attempts per competitor per event is allowed. Exceptions are due to malfunctioning launch equipment or faulty rocket motor due to manufacturer defect. Launch attempts stop at 4pm. It is up to the competitor to manage their time.
24	Rockets may not use any externally-generated signals such as radio or computer control for any purpose, including flight termination, after liftoff. Autonomous on-board control systems can be used.
25	No guidance systems are allowed.
26	Boosted darts are not allowed.
27	The igniter is to be installed at the launch pad when the rocket is in the vertical position.
28	Competitors attempting unsafe recovery from trees or power lines will be disqualified. If a rocket lands in a tree or power line, an official needs to be notified to make a safe recovery.
29	The altimeter used for altitude measurement must not be removed from the rocket or turned off until in the presence of a judge.
30	If a team chooses to use a hybrid rocket motor, the team must provide all ground support equipment.
31	All electronics power must support up to an hour delay on the launch pad.

32	No sparky motors or any type of motor that can generate sparks.
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Launch Systems

Launch pads will be provided and have six foot long 1 inch (1010) aluminum rails. 8 foot 1.5 inch (1515) aluminum rails will also be provided. The rails are to be vertical. They cannot be angled at all. Teams can substitute with their own launch equipment. Student launch equipment must be inspected before use for safety.

The following table is the rail requirements.

Rail	Max Motor Size	Rail Buttons	On Pad Max Weight (lb)	Max Rocket Diameter (in)	Rail Length (feet)
1010	J	1010	15	6.0	6
1515	L	1515	25	7.5	8
Unistrut	O	Unistrut/1515	100	18	20

Practice Flights

Teams can perform test flights any time during the year up to the competition. The teams must perform test flights at sanctioned rocket launches supported by NAR or Tripoli. If testing with high power rocket motors, a team member must be certified or the team must find a person at the launch with proper certification to purchase and assemble the rocket motor for the team. Teams must follow all regulations when flying with high power rocket motors. Do we need to mention that the person holding the certification must be a member of the certifying organization in good standing?

Disqualifications

A team will be disqualified for the following reasons:

1. Recovery system does not deploy and the rocket free falls or comes in ballistic.
2. One or more parts of the rocket free fall from the rest of the rocket.
3. Rocket motor separates from the rocket during any part of flight.
4. Rocket is damaged beyond field repair after flight.
5. Team acts in a dangerous manner.
6. Team misbehaves and interferes with other team's progress.
7. Team does not launch before the end of flying.
8. Team attempts an unsafe recovery. An unsafe recovery is defined as attempting to remove any part of a rocket out of power lines or trees that require climbing. Rockets

can be pulled out of trees or other vegetation if the team member can reach any part while standing on the ground.

Competition Operations

The opportunity to launch begins at 10AM Saturday and ends at 4PM Sunday. All contestants must be on the launch pad no later than 4pm. The contest ends at 5PM allowing for recovery time after the 4PM end time.

There will be a designated ground station area along the flight line for all teams participating in events that require a ground station. This will allow the judges to stay in one area and score the teams more efficiently. Teams need to bring a small table to support their ground station.

For the planetary lander events, teams must locate a judge for their ground station to be scored. A field judge will verify lander has uprighted.