National Aeronautics and
Space Administration

Educational Program	
Educators & Students	Grades 9–12

EP-2002-08-393-HQ

NASA
Student Involvement Program

Space Flight Opportunities

NASA's mission is

- To understand and protect our home planet,
- To explore the Universe and search for life,
- To inspire the next generation of explorers *as only NASA can.*

Resource Guide
2002–2003
National Competitions

National Aeronautics and
Space Administration

NASA's vision for the future is:

- To improve life here,
- To extend life to there,
- To find life beyond.

NASA's mission is:

- To understand and protect our home planet,
- To explore the Universe and search for life,
- To inspire the next generation of explorers as only NASA can.

You may obtain the official Entry Packet for the 2002–2003 competitions by downloading it from the NSIP website, ***http://education.nasa.gov/nsip***, or you may contact us by e-mail (***info@nsip.net***) or by telephone at 1-800-848-8429.

This Resource Guide is designed to help you explore how space flight experimentation can be an exciting part of your science courses. This newly revised Guide includes descriptions of two opportunities to send your experiment to space, either on a **Space Shuttle (SEM)** or on a **NASA sounding rocket (SubSEM).** New sections and resources have been added to the Guide, including recommendations for preparing experiments: "A Teacher's Perspective on Space Flight Opportunities," written by a teacher for other teachers, and "An Informal Guide to SEM," written by students for students. More information has been included about student experiments that have flown in Shuttles and sounding rockets in the past. Use this Resource Guide together with the official NSIP Program Announcement poster which provides full details on the NSIP Program, including a complete statement of rules, and forms for submitting your entry.

Since rocket launches occur in June, and Space Shuttle launches usually occur no less than one year after student experiments are submitted, designing, building, and flying an experiment and reporting the results will extend beyond a single school year. This is just one of the reasons a strong team is needed in order to get the most out of this opportunity. The chance to fly a significant science experiment in space is unique, and the rewards are great. Good luck!!

NSIP Space Flight Opportunities Competition

Space Experiment Module (SEM)
Suborbital Student Experiment Module (SubSEM)

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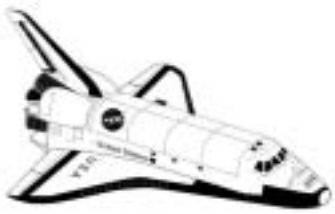
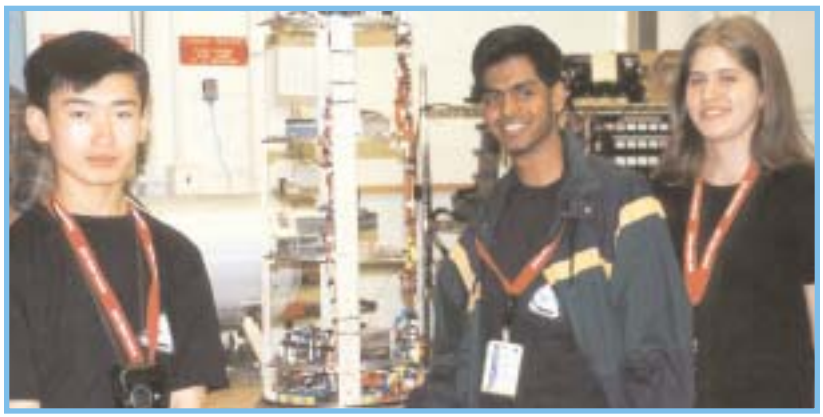
Competition Categories

Grades 9–12 . . . . . Teams

Space Flight Opportunities

Here's your chance to design an experiment and send it to space! Living and working in space will become a reality for many of us in the 21st century. We are poised at the edge of a new frontier. The International Space Station represents the first step toward permanent human habitation of space. At the forefront of this giant leap is NASA's effort to understand the space environment and how it affects us. What happens to biological functions? How are basic physical and chemical processes affected? If the results of past space experiments are any indication, many new findings await discovery and investigation. The exploration and development of space depends on our growing understanding of important facts through basic experimentation and research. This is a unique opportunity to join that effort! Are you interested?





Design, Build, Fly!

Here's an overview of the process involved in the Space Flight Opportunities competition. More details about the steps follow.

1. Select an experiment. Think about different possibilities for space experimentation. Study the experimental setting that space offers, such as reduced gravity, increased radiation, temperature and pressure variations, etc. Refer to resources contained in this Guide and on our web site (http://nsip.net/rev/f_toc.html) to learn more. We have also extended our library of past experiments to give you an idea of various types of projects that might serve as models for you.

2. Submit a Letter of Intent; get access to experts. NSIP staff will offer you access to a pool of experts who will provide guidance and feedback during your proposal and design process. Submit a Letter of Intent of 500 words or less. This can help you improve the quality of your entry significantly. While there is no "due date" for receipt of the letter, sooner is clearly better. Your Letter of Intent should present your preliminary plans, including scientific objective, technical plan, and team organization. This will help us find suitable advisors for your project. Email us at spaceflight@nsip.net.

3. Conduct ground-based research. Running experiments in the controlled setting of your laboratory will give you the best preparation for running a similar experiment in space.

4. Submit an Official Competition Entry. Rules and forms are included in the official NSIP Program Announcement brochure which provides full details on the NSIP Program, including a complete statement of rules and forms for submitting your entry.

5. Announcement of winners. If your experiment is selected, NASA will supply necessary hardware and technical support as you prepare your experiment for flight.

The Sky Is Not the Limit!

The ground shakes and the roar is so loud that it vibrates through your body. Atop a mighty column of fire and smoke, the giant rocket leaves the ground, slowly at first, but rapidly reaching almost incomprehensible velocities. NASA has launched another probe into space, and, like those that came before, it is one of the great achievements of humankind. Yet this launch is not the exclusive domain of "rocket scientists," those fabled few who create the technologies that make such launches possible. This mission carries experiments conceived, designed, and built by students. These high school students have a vested interest in this launch, just like the highly trained professionals at mission control.

The Stuff of Dreams

For countless generations, space exploration was the stuff of dreams and science fiction. Now the thrill, challenge and rewards of space discovery are accessible to high school classrooms. NASA is launching student experiments and probes alongside those of scientists. The opportunity to actually explore space is now within the grasp of your class.

Hard work, ingenuity, and unbridled curiosity are what distinguish students whose experiments have been launched into space. Students from Wading River, NY, devised an experiment to test how the reduced-gravity environment of space affects genetic recombination. Students from Albuquerque, NM, learned how such an environment affects crystals. Others, including students from a school in Mitchellville, MD, studied the impact of the environment of space upon common features of Earth's environment, such as soil, water and seeds. Girl Scouts from Salisbury, MD, wanted to see how space flight affects common items of food. You and your students can tap into extraordinary learning opportunities and derive an ineffable sense of accomplishment and experiences rich enough to endure a lifetime.

Group Effort Is a Key to Success

Two things are indispensable: a good idea and a tight-knit team devoted to pulling all the details together and making it happen. Does your team have the "right stuff" to undertake the project and sustain it for the duration? We can help you develop your good idea by supplying you with details of past experiments and providing access to scientists and engineers who have developed and flown experiments in space. Your team spirit becomes especially important after your proposal has been reviewed by NSIP's panel of scientists, engineers, and educators. The review process has two possible outcomes: "Selected" and "Finalist". Being "Selected for Student Flight Week," means that your proposed experiment is considered to be ready to be built and "integrated" for flight. If you are a "Flight Opportunity Finalist," this means that your proposal is in the running, but needs to address specific scientific and technical issues before it can be selected. In either case, your team must continue to work in order to get the proposal to the next stage. Can your team members be there for that? Those selected in a given year will begin building and testing their experiment in preparation for the final week of integration into an experiment module at the NASA Wallops Flight Facility. For finalists it means they must be prepared to redesign, possibly even reconceive certain aspects of their experiment in preparation for resubmitting the proposal for review and possible selection in the next round.

Implementing National Science Education Standards

The aim of national science education standards is to give students direct experience of the wonders of science—not just facts, but the actual experience of making discoveries firsthand. Space Flight Opportunities Competition doesn't "address" the standards; it brings them to life.

Overview: Experimentation in Space

Historical Background

Space flight is a reality only because thousands of researchers and other experimenters worked for decades to understand how technologies and people can function successfully in space. Their experiments also managed to answer some important questions about Earth. The first probes sent aloft were aboard balloons, but they were unable to leave the atmosphere. A breakthrough came with the development of modern rocketry. Although crude rockets had flown for centuries, Robert Goddard, after whom the NASA Goddard Space Flight center is named, was first to design and build rockets able to carry research tools much higher into the atmosphere than balloons could go. In 1929, he launched the first rocket to carry instruments—a barometer, a thermometer, and a small camera. Soon, technological advances enabled the development of larger, more powerful rockets capable of carrying increasingly sophisticated payloads into space itself. Your students will become explorers this tradition.

Science Themes for Projects

The possibilities are endless. A few of the more common themes are highlighted here to launch you and your students on a voyage of exploration and discovery!

Physical Conditions of Space Flight. Before human beings flew in space, researchers conducted countless experiments to learn about the conditions inside a rocket in flight. Jarring vibration, sudden and intense acceleration, rapid spinning, brief or sustained weightlessness, harsh solar radiation, increased cosmic radiation, and extreme temperatures are some of the critical features associated with space flight. To appreciate these conditions, imagine carefully monitoring an experiment while riding on a speeding roller coaster. On the Space Shuttle, your experiment will undergo about 5 gs during launch. The unmanned Orion sounding rocket used for the SubSEM launch accelerates at 15 gs off the launch pad. It goes from 0 to 100 mph in 0.3 seconds, in its first 23 feet of travel. Half a minute later, it is going 1700 mph and spinning four revolutions per second. Quite a ride for your experiment! As it approaches its highest altitude (around 45 kilometers), the rocket's spin can be dampened to create conditions of near-zero gravity at the apex of its trajectory, for about one minute. You can design your experiment to learn about the behavior of materials and objects under such extreme conditions to help us better understand the physics of daily life. For more details on these conditions, consult *A Teacher's Perspective on Space Flight Opportunities,* in Appendix B.

Studying Earth's Atmosphere. Some of the earliest rocket-launched experiments studied the upper levels of our atmosphere that were inaccessible to aircraft. When stratospheric ozone depletion was suspected in the 1970s, rocket-borne instruments were used to measure how ozone levels varied with altitude as well as to help trace the fate of ozone-destroying chemicals. Scientists today use rockets to study what happens when the solar wind strikes the Earth's ionosphere. There is a lot more than ozone up there: other chemicals, aerosols, magnetic fields, cosmic rays, and other forms of radiation abound. These fields, interactions, and constituents, which occur at altitudes too high for aircraft but too low for satellites to measure, affect conditions on Earth in ways that are proving to be increasingly important. Sounding rockets represent a practical way to fly instruments to these altitudes, and even take samples!

Chemistry and Life in Microgravity. We, of course, take gravity for granted in our daily lives, but what is life like in space where there is no gravity? We have learned that we can live without gravity, but we are still researching the potential benefits, difficulties, and effects on

biological tissue in a gravity-free environment. "Microgravity" refers to situations where gravitational effects are minuscule or absent (consult NASA's Microgravity web site to see the full research program of this science frontier: http://microgravity.msfc.nasa.gov). Some things that are difficult or impossible on Earth are practical in space. For example, it may be possible to create valuable chemical compounds in microgravity that could not be made on Earth. On the other hand, some routine tasks on Earth can be challenging in microgravity. There is research that focuses on ways to make life healthier and more comfortable for astronauts. (Can we grow fresh vegetables on the International Space Station? Can astronauts take showers?) SEM experiments are subject to microgravity for hours or days, a condition which simply does not occur on Earth. Here are some basic issues:

1. Chemical reaction requires some kind of mixing or diffusion process. On earth this process is strongly shaped by gravity. Even the shape of a flame changes depending on the presence or absence of gravity. Everything from the rate of reactions to their yield could be affected in interesting and possibly useful ways. A recent example makes this dramatically clear: findings from John Glenn's historic return to space in a recent Shuttle mission (STS-95) indicate that the efficiency of antibiotic production in the reduced gravity environment of space increases by 200%!

2. Biological processes evolved in the "gravity-rich" environment of the Earth. Simple things, like directionality (up vs. down) are defined solely on the basis of gravity "pulling things down." Gravity provides "cues" for a variety of life processes like the growth and development of plant roots and stems, and our own sense of balance. Although plants do grow in space and astronauts do regain their sense of balance, many interesting questions can be formed around the adaptations of biology to space travel. If space is our future, then answers to these questions will help us get there sooner.

Two Distinct Opportunities: The SEM and SubSEM Flights

As you plan your experiment, you'll need to consider the difference between the two kinds of flight opportunity that NASA has made available through NSIP. The SEM and SubSEM accommodations are quite different. Here is a brief introduction to the two types of flights. Though there are some big differences between these two ways of conducting space experiments, both present fantastic opportunities. Most space researchers take advantage of the Suborbital opportunities to learn from their experiments before getting a place on the Shuttle's crowded schedule. If you select the SEM (Shuttle) opportunity, consider adapting your design proposal for simultaneous submission as a Suborbital experiment (Sub-SEM). Consult Appendix B and C of this Guide to learn more about the types of experiment that might be suitable for each venue.

Suborbital Rocket

Called the "Sub-SEM," for "Suborbital Student Experiment Module," this opportunity involves mounting an experiment in a rocket that reaches an altitude of about 45 kilometers) and then returns to Earth. For about 60 seconds your experiment experiences: a) the microgravity of the space environment; b) exposure to space temperature and radiation levels; and c) a clear view of the universe that only the Hubble Space Telescope can beat. That brief time is sandwiched between several minutes during which the rocket slices through every layer of the Earth's lower atmosphere, getting up close and personal with ozone, ions, and other atmospheric constituents. Students watch the rocket launch their experiment into space, and return it to Earth for analysis. The rocket will be launched, weather permitting, while the teams are at the NASA Wallops Flight Facility in June 2001.

SubSEM Experiment Accommodations

SubSEM experiments fly on a single-stage solid-fuel NASA Orion sounding rocket. It is 14 inches in diameter and 225 inches tall. The rocket is launched (weather permitting) exclusively to carry student experiments during Flight Opportunity Week while the project teams are at Wallops Flight Facility. After flight, the payload section will be recovered by ship, and the experimental apparatus and data will be given to the teams for their analysis.

Electrical power and electronic data recording and control equipment are provided as they are for the SEM flights, but SubSEM experiments may be energized before launch and during the entire flight. Additionally, video recording equipment can be made available for some experiments. The payload portion of the rocket includes four sections, each of which houses a single experiment mounted on a circular Experiment Mounting Deck. Experiments may be up to 9 inches tall. Each section includes a 5 inch by 5 inch access door, and may include ports or a window. Construction of SubSEM experiments must be very sturdy because of the launch acceleration and rotation of the rocket. If an experiment involves liquids, it must also include a secondary containment system.

Left: SubSEM rocket payload exterior.
Right: SubSEM deck mounting structure.

Space Shuttle

The "Space Experiment Module," or "SEM," is an opportunity to send your experiment to space for a period of about one week, as the Space Shuttle orbits the Earth. Once the Shuttle reaches orbit and opens its cargo bay doors, your experiment is exposed to the space environment. The extended period of time allows for a variety of long duration experiments, and is conducive for biological research. Because human beings are on board every Shuttle flight, safety requirements for SEM experiments are detailed and stringent (for details, refer to http://www.nsip.net/resources.html#flight). One aspect of the challenge is to form a team and to design an experiment that can withstand the long wait prior to launch. While Sub-SEM will be launched on a sounding rocket every summer, getting a SEM on the Space Shuttle will not occur until sometime during the following academic year, at the earliest, depending on the Shuttle's busy schedule.

Experiment Assembly Expanded View

SEM Experiment Accommodations

News coverage of Space Shuttle flights is now so routine that you may be accustomed to hearing descriptions of the payload that include the words "… and a number of other experiments." The Shuttle Small Payloads Program arranges for experiments to fly on the Shuttle whenever cargo capacity is available. A special container about the size of a 55-gallon oil drum has been developed to carry such experiments and is called a Get Away Special Canister, or GAS Can. It offers scientists a relatively affordable way to send self-contained experiments on board the Shuttle. The SEM program uses a special version of the GAS Can equipped with 10 Student Experiment Modules, a battery to provide electrical power, and electronic data recording and control equipment. The electrical equipment is energized only while the Shuttle is in orbit. Active experiments (which make use of the electrical power and control or data collection electronics) use software available on the web for control and measurement. Passive experiments (which fly materials, but do not make use of the electronics) may optionally make use of Space Capsule containers—clear, sealable, polycarbonate vials 1 inch in diameter and 3 inches long. Twenty-two of these fit in foam pads inside a SEM. Either kind of experiment may be mounted to an Experiment Mounting Plate using screws, nuts, and washers supplied by NASA. If your team's experiment is selected for flight, NASA will supply the Space Capsules or Mounting Plate. Sturdy construction is necessary to withstand the acceleration and vibration of launch.

Space Experiment Module

For More Information

Technical details can be found in Appendices B, C, D of this Guide (p.18). Visit the Space Flight Opportunities section of the NSIP web site ***(http://www.nsip.net/flight.html)*** frequently for additional technical and reference information about the two types of flights and their accommodations for experiments. Any team that is making final plans to prepare a specific experiment will need to refer to the details found on the web site for the particular flight. The web sites also have links to related pages that can be very helpful. If you have further questions, write to ***spaceflight@nsip.net.*** Project staff will add to the Frequently Asked Questions section of the NSIP web site.

Six Steps to Develop an Experiment

Planning a productive experiment involves studying the flight environment and how it affects things you find interesting. It is important to select something to study that has a realistic chance of being affected by the conditions of flight. What follows is a general set of considerations for your experimental design process. Particular documents are referred to at various steps since they provide the kind of details, examples and activities you might need for a clear idea of how to proceed. The section that follows these six steps contains the judging rubric for this competition area: these will inform you about how the judges will evaluate and select experiments for flight.

I. Study How Flight Conditions Differ from Ground Conditions

The SEM and SubSEM flights each provide unusual environments for experiments. SEM experiments experience microgravity conditions during most of the Shuttle flight and receive increased exposure to cosmic rays. SubSEM experiments travel from sea level through nearly all of Earth's atmosphere and can include a window or gas-sampling port. Solar radiation above the atmosphere is much more damaging to living things than is ground level sunlight. These are only a few of the conditions to consider. (See *Microgravity: A Teacher's Guide,* NASA Publication # EG-1997-08-110-HQ , available as hardcopy, and electronically from NASA Spacelink at ***http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/*** —select "Guides.")

II. Consider the Effects of Those Conditions

Pick a particular condition of rocket flight that is different from normal conditions on the ground and investigate its likely effects. For example, higher levels of cosmic radiation of space flight might alter data stored on magnetic media or in computer memories. You may want to consider the effects of several different conditions. NASA publications describe a wealth of effects of gravity and microgravity. Even though SEM and SubSEM experiments do not fly human beings, you may want to ask "How would things around us be different if we were launched on a rocket?" (See Teachers and Students *Investigating Plants in Space,* NASA Publication # EG 1997-02-113-HQ, available as hardcopy, and electronically from NASA Spacelink at ***http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/***—select "Guides.")

III. Find Ways to Study Those Effects: Passive and Active Experiments

Your experiment could make use of DC power, sequencing signals, and recording equipment supplied by NASA. Such experiments are classified as "active." For example, a team might construct for SEM flight a small electrical device with sources of heat and temperature sensors to learn how heat is dissipated without the gravity-

driven convection currents that help cool things on Earth. "Passive" experiments send materials into space and then study them on the ground after their return to learn how they may have been affected by their flight. For a more detailed discussion of these and other points pertaining to space flight experimentation, see *A Teacher's Perspective on Space Flight Opportunities,* in Appendix B of this Guide (p.18). Also, see *Designing SEM Experiments: An Informal Guide for Students by Students,* in Appendix C of this Guide (p.18).

IV. Carry Out Ground-Based Experiments

Although the conditions of rocket flight are difficult if not impossible to duplicate on Earth, you may find ways to experiment with similar phenomena on the ground. For example, if you are interested in measuring how sky light changes as the rocket rises through the atmosphere, you could study how sky light is affected by the changing angle of the sun in the sky. Or, if you are interested in how seeds grow after a trip into space, you could experiment with how seeds grow after exposure to different conditions on Earth. For more information about the latter, see *Seeds in Space: An Example,* in Appendix A of this Guide.

V. Submit a Letter of Intent and Get Access to Experts

NSIP staff will get you access to a pool of experts who will provide guidance and feedback in your design and proposal process. Submit a Letter of Intent of 500 words or less. This can help you improve the quality your entry significantly. While there is no "due date" for receipt of the letter, sooner is clearly better. Your Letter of Intent should present your preliminary plans, including scientific objective, technical plan, and team organization. This will help us find suitable advisors for your project. Email us at ***spaceflight@nsip.net.*** To see what other teams have done in the past, consult reports from the *1999 Shuttle Small Payloads Program Symposium,* included here as Appendix D.

VI. Continue Your Work to Prepare to Fly

At this stage, you have built a solid foundation for your work. If your experiment is not selected for flight after your first Entry, you have an excellent head start for next year. Look for ways to communicate your progress to your peers and to others who can support your work. Science fair projects and other presentations are a good way to do this. You may want to enlist the aid of other teachers, scientists, engineers or professors in your area. Inviting new members to join your team is an important step that merits careful attention.

Prepare Your Entry

ENTRY COMPONENTS

Scientific Objectives

Describe briefly and clearly the purpose of your proposed experiment. What research question would it help answer? Explain why orbital flight or rocket flight would be necessary to fulfill the purpose of this experiment. Describe what ground-based control experiments you could perform if the experiment is selected.

Technical Plan

Describe and diagram the experimental apparatus that would be used, including any special hardware requirements. Show that your experiment could function in spite of expected pressure and temperature variations, acceleration and vibration of launch, and storage periods before and after launch. Detail your experiment's expected sequence of operations during the flight.

Team Organization

Show that the team is well-composed, with enough people with the right skills to share project tasks, even after the graduation of senior members of the team. If possible, include evidence of past teamwork efforts, such as successful science fair projects. Describe your plans for effective team cooperation, including reasonable division of labor showing how the team would work together. Describe how plan to or have already enlisted the support of your school and community.

Resource Credits

List all reference books, periodicals, web sites and people (including names, work titles, and type of help provided) contributing to your proposal. (This section is not included in the word count.)

Space Flight Opportunities Judging Rubric

Grades 9–12

This rubric is designed for all grade levels. Teachers should adapt the rubric to match their students' ability levels.

Entries must meet the following minimum standards. Entries not in compliance will not be judged.

- Entries must present a research question and a technical plan.

A. SCIENCE OBJECTIVES 40 Points Maximum

LEVEL	1. RESEARCH QUESTION AND HYPOTHESIS *What is the research question? Does the hypothesis focus the investigation of that question? What variables were selected for study?*	2. EXPERIMENTAL RESEARCH PLAN *Does the planned experiment clearly address the research question? Will it yield relevant data?*	3. POTENTIAL SCIENTIFIC VALUE TO ANSWERING THE PROPOSED QUESTION	4. POTENTIAL PRACTICAL VALUE TO ANSWERING THE PROPOSED QUESTION
0	Neither research question nor hypothesis are detected.	No clear experiment plan is apparent.	It is likely to have little or no effect on scientific understanding.	The results are unlikely to be useful or relevant.
1	An unclear research question or hypothesis is stated.	Plan is unclear, most steps are missing or confused; the experiment relates poorly or not at all to the research question.	N/A	N/A
2	A research question and hypothesis are present but both are poorly stated, or may contain inaccuracies.	Plan is clear, main steps are present, and somewhat related to the research question and hypothesis, may yield significant data.	It is interesting and likely to contribute to better understanding of a scientific topic.	The results are likely to be useful or relevant.
3	A clear research question and hypothesis are present but not testable, variables are not identified, or contain inaccuracies.	Plan is clearly stated, most steps are present, and experiment will yield significant data related to research question hypothesis.	N/A	N/A
4	The research question is clear, the hypothesis is testable, variables are identified; variables are identified as dependent, independent, and control is defined.	Plan is clearly stated, experiment will yield data that address research question and hypothesis in a compelling way.	It is interesting and may make a significant contribution to scientific understanding.	The results are likely to address a significant problem.
	Level _____ × 3.75 = _____ points	Level _____ × 3.75 = _____ points	Level _____ × 1.25 = _____ points	Level _____ × 1.25 = _____ points

Subtotal points from this page _____

B. TECHNICAL PLAN 35 Points Maximum

LEVEL	5. OVERALL *Is there a clear description of a thorough technical plan, accounting for both flight and pre-flight conditions?*	6. EXPERIMENTAL APPARATUS *Is the planned experimental apparatus practical and flight-worthy?*	7. GROUND-BASED EXPERIMENTS *Is the plan supported by ground-based experiments?*	8. PASSIVE EXPERIMENT TECHNICAL PLAN *Is there a plan for obtaining and analyzing useful data from returned samples?*	9. ACTIVE EXPERIMENT TECHNICAL PLAN *Can the proposed experiment function properly under the specific flight opportunity conditions?*
0	No technical plan is presented.	Impractical; not correctable.	No plans given for such experiments.	No plan is presented.	No plan is presented.
1	Plan is vague or confusing.	May work, if substantially modified.	Team intends to conduct such experiments.	Plan mentions data or data analysis, but provides no specifics.	The experiment is not suitable for the proposed flight (e.g., requires human attention during the flight).
2	A good start, but many key questions are not addressed.	Will work, if moderately modified.	Entry includes plans for such experiments.	Plan will likely yield data unrelated to research question, requires major modifications.	Plan is not clearly described; there appear to be serious technical problems
3	Reasonably clear, but some key questions are not addressed.	Will work, only minor issues remain.	Team conducted some related experiments.	Plan will likely yield relevant data, provides plans for appropriate analysis, but has implementation issues (e.g., requires mass spectrometry).	The experiment seems practical, but the plan doesn't sufficiently address the issues.
4	Clear and thorough, most key questions are addressed.	No problems.	Tech plan includes results of relevant successful experiments.	Plan will likely yield relevant data, plans for appropriate analysis are practicable, but requires little, if any, modification.	The technical plan is clear, complete and an excellent match for the flight opportunity or requires only small changes to adapt the experiment to the conditions of flight.
	Level _____ × 1.25 = _____ points	Level _____ × 1.25 = _____ points	Level _____ × 1.25 = _____ points	Level _____ × 2.5 = _____ points	Level _____ × 2.5 = _____ points

Subtotal points from this page _____

C. TEAM ORGANIZATION 25 Points Maximum

LEVEL	10. TEAM COMPOSITION *Do team members have relevant skills to carry out the project, even after the graduation of senior members of the team?*	11. TEAMWORK PLAN *What is the plan for effective team cooperation?*	12. TEAM SUPPORT *Has the team effectively enlisted the support and cooperation of the school and community?*
0	No information is provided.	No information is provided.	No information is provided.
1	The team appears to be too small or ill-prepared.	Vague and insufficient statement (e.g.,"We will cooperate.").	The team has considered what type of support they require.
2	The team appears well-composed, but the work appears to be too complex for them.	Description of reasonable division of labor is provided.	The team presents a plan to enlist the support they require.
3	The team appears well-composed, with enough people with the right skills to share project tasks.	Description of reasonable division of labor and plans (i.e., task lists, schedules) are provided about how the team would work together.	Qualified individuals have volunteered for specific tasks.
4	The team is well-prepared.	Members of the team have worked together successfully in the past (e.g., they had a successful science fair project, team project, other competitions, etc.) and have provided a description of a reasonable division of labor.	Qualified individuals have already contributed.
	Level _____ × 2.5 = _____ points	Level _____ × 2.5 = _____ points	Level _____ × 1.25 = _____ points

Subtotal points from this page _____

Total points _____

Improve Your Chances

Write a Letter of Intent: Enlist the Support of a Mentor

Experimental science is usually learned through personal experience with other researchers rather than from books. As your team develops some experience in a field of research, you may be able to find someone outside your school, perhaps at a college or in industry, with experience in that field. As mentioned earlier in this Guide, NSIP staff will help you access a pool of experts who will provide guidance and feedback in your design and proposal process. Submit a Letter of Intent of 500 words or less. This can help you improve the quality your entry significantly. While there is no "due date" for receipt of the letter, sooner is clearly better. Your Letter of Intent should present your preliminary plans, including scientific objective, technical plan, and team organization. This will help us find suitable advisors for your project. Email us at **spaceflight@nsip.net.**

Review Reports and Summaries of Past Experiments in Space

All knowledge builds on past experience. Even geniuses rely on past knowledge—even if they have look beyond it. Newton is quoted as saying, "If I have seen farther, it is because I have stood on the shoulders of giants." OK, so even if you are not a genius, and you don't know any giants to climb on, you should make a point of seeing what has been done, and how it worked out. A lot of scientific progress occurs when experimenters test the limits of "received knowledge." Check out our web site frequently to find out more.

Review the Judging Rubric

Understand how your entry will be evaluated by the judges. Find out what they will look for in your presentation of your science objective, your technical plan, and your team's organization.

Team Spirit, Team Work

Good ideas, however clearly explained are not enough to make it fly: there has to be a team behind it all to carry it through. Many skills are needed for flight experimentation, and the work is more fun when shared by people who enjoy the different aspects. Pay specific attention to putting together a diverse team and sharing the work and rewards fairly. Analyze the tasks ahead and ask which team members would enjoy doing each one. Take time to plan realistic schedules. As your project continues, some members of your team may have to move on to other pursuits (like college!) so be prepared to thank them appreciatively and continue your project: the show must go on.

Keep Up to Date with the NSIP Web Site

The Space Flight Opportunities program is unique within NSIP because web access to the detailed technical material at the SEM and SubSEM sites is practically required in order to develop a winning entry. Technical details regarding the flights may change, but ***http://www.nsip.net*** can keep you up to date. The web also makes it practical for NSIP staff to continue to add helpful resources, and you are invited to send suggestions to ***spaceflight@nsip.net.***

Arrange for Outside Review of Your Work

Set up a small informal advisory board of two to four people to review your work a few times a year. It might be helpful for one or two of them to have some knowledge of science, but experience with successful teamwork on an extended project is probably more relevant. Meet with them to describe the Space Flight Opportunities Program and your plans for experimentation. When you prepare a Letter of Intent and Competition Entry, give it to your advisory board for review far enough in advance so you have time to act on their suggestions.

Pay Scrupulous Attention to Details

See the next page for a sample.

Make Your Summary Count

The fifty words (maximum) of your summary can show why your entry merits careful attention by the judges. It is also your best chance to interest anyone who browses the list of entries. Explain clearly what you hope to learn from your experiment, and how you plan to do so.

Pay Scrupulous Attention to Details

This paragraph is set in 12 point type double-spaced, according to the requirements described for Competition Entries. That is one of many NSIP rules. Type set this way lacks visual appeal, but judges who must review many entries appreciate its clarity and simplicity. Also note the generous 1.25 inch margins. Many of the requirements may, at first glance, seem arbitrary. Success in space flight depends on understanding the requirements and meeting them completely. If your experiment flies on the Space Shuttle, it will fly with people on board who depend on the careful attention to detail of many thousands of other people. Show that you can meet the flight requirements completely by submitting your Letter of Intent and Competition Entry exactly according to the guidelines in the Program Announcement.

Resources

Be sure to refer to the current year's Program Announcement for dates and details of the Competition as well as the Entry Form which is required in order to submit an entry. ***http://www.nsip.net/competitions/spaceflight/index.cfm*** *is the best place to look for additional resources because that list can be kept up to date.*

Here are several sources of related information:

- GADGET: Glenbrook Aerospace Development Get-away Experiment Team ***http://gbn.glenbrook.k12.il.us/GADGET/home.htm***
- Shuttle Small Payloads Project ***http://sspp.gsfc.nasa.gov/***
- The Space Experiment Module ***http://www.wff.nasa.gov/~sspp/sem/sem.html***
- NASA's Sounding Rocket Program ***http://www.wff.nasa.gov/pages/soundingrockets.html***
- NASA Spacelink: Guides ***http://spacelink.nasa.gov/products/#EG***
- The NASA History web site ***(http://history.nasa.gov/)*** is an excellent source of information concerning the full range of rocket-borne experimentation, and a good basis for student reports on previous experiments.
- The National Association of Rocketry ***(http://www.NAR.org)*** runs programs related to rocket flight and to rocket-borne experimentation. Their web site links to the related Student Experimental Payload Program ***(http://www.SEP.org)*** which offers educational materials and flies student payloads on sounding rockets.
- ***Rocket Boys*** by Homer H. Hickham Jr. (the basis for the movie *October Sky*) is substantially biographical, but also addresses the kind of teamwork and community support that can lead to amazing success.
- NASA Educator Resource Centers (see the Program Announcement for contact details) offer many materials, such as the "Toys in Space" videos filmed on board the Space Shuttle.
- Space Experiment Reference Library ***http://www.nsip.net/resources.html#flight***
  - *Seeds in Space—An Example*
  - *A Teacher's Perspective on Space Flight Opportunities*
  - *Designing SEM Experiments: An Informal Guide for Students by Students*

  Reports of past student experiments from the *1999 Shuttle Small Payloads Program Symposium*

  SSIP National Winners 1980–81

Please submit your suggestions for additional resources to ***spaceflight@nsip.net.***

Appendices

The following Appendices are now available in the Space Experiment Reference Library of the Resource Section at ***http://www.nsip.net/resources.html#flight***

A. *Seeds in Space—An Example*
by Paul Wagoner, TERC

B. *A Teacher's Perspective on Space Flight Opportunities*
by Lynne Zielinski, Glenbrook North High School, Northbrook, IL

C. *Designing SEM Experiments: An Informal Guide by Students for Students*
by Saif Choudhury and Paul Jung, Glenbrook North High School, Northbrook, IL

D. Reports of past student experiments from the *1999 Shuttle Small Payloads Program Symposium*

E. SSIP National Flight Opportunities Projects 1980–1984