2027 DROP TOWER CHALLENGE
Fluid Shift

Guide with Instructions

https://www.nasa.gov/glenn/glenn-expertise-space-exploration/physical-sciences-program/education-and-outreach/current-drop-tower-challenges-and-competitions/

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A. CHALLENGE OVERVIEW

Why?

Future space exploration requires a better understanding of fluid behavior in microgravity because of the cooling, life support, propellant, and other spacecraft systems which include liquids. Especially in the apparent absence of gravity, the shape and nature of a surface can affect how liquids interact with it, for example within a channel or container. Furthermore, hydrophilic (water-loving) and hydrophobic (water-fearing) surfaces or coatings can have additional effects which are more pronounced in microgravity.

While it is hoped that you will learn about both fluid physics and microgravity research, you can more importantly learn by following the engineering design process (Figure 1) and scientific method (Figure 3). This can be done with this challenge by moving from a problem statement, to hypotheses, the design and preparation of your experiment, testing & analysis – ideally repeatedly with the refinement of your design – and finally reporting.

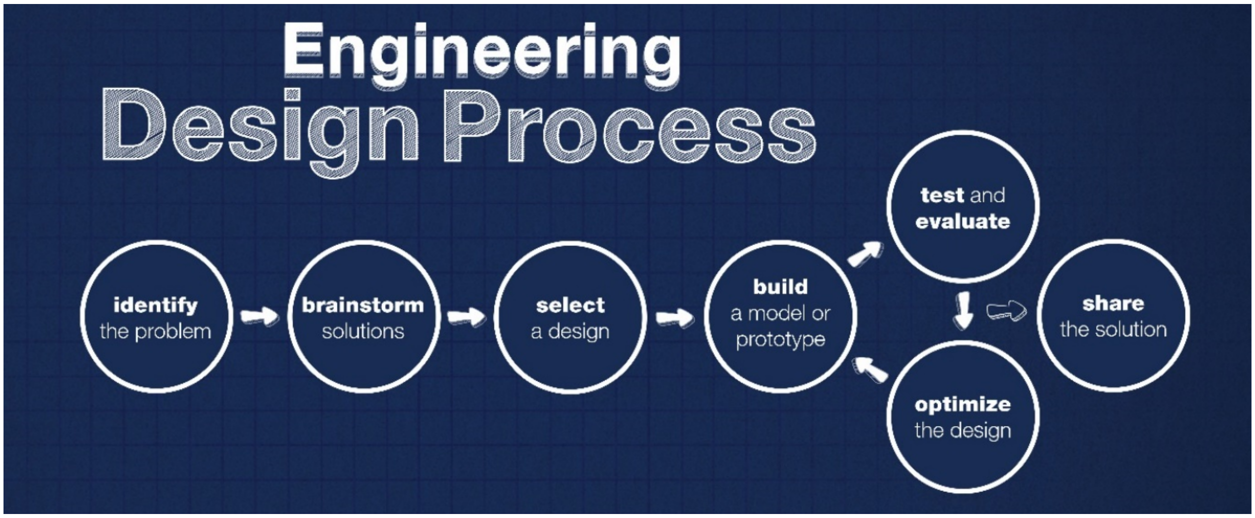

Figure 1 - Engineering Design Process

And while the challenge wasn't developed to specifically address any current issues or applications, your approach to the challenge may inspire NASA to address microgravity fluid management in a new way.

Participation in a nationwide NASA design challenge might be worth noting in applications for college, etc. Regardless, it is hoped that the challenge will inspire you to pursue a career in STEM (Science, Technology, Engineering, and Mathematics), perhaps even at NASA.

What?

Teams of grade 8-12 students are challenged to design and build small devices that will experience apparent weightlessness, i.e. microgravity, in NASA's [2.2 Second Drop Tower](). Each test object will be placed with water (and a little liquid soap) in a plastic vessel. Each device must suck in as much water as possible during the fall, where that will be evaluated by the drop in the vessel's water level.

Teams are only responsible for their test object; NASA will provide the rest of the experimental hardware. After developing their concepts, the teams prepare their proposal, consisting of conceptual drawings and a short entry form, which is e-mailed to Ed-DropTower@lists.nasa.gov.

If selected, the teams prepare their devices based on provided guidance. The test objects are then sent to NASA where they are received and installed in the drop tower (Figure 2) and then will fall 24 meters (79 feet). Video results of the microgravity testing are provided for student analysis and reporting.

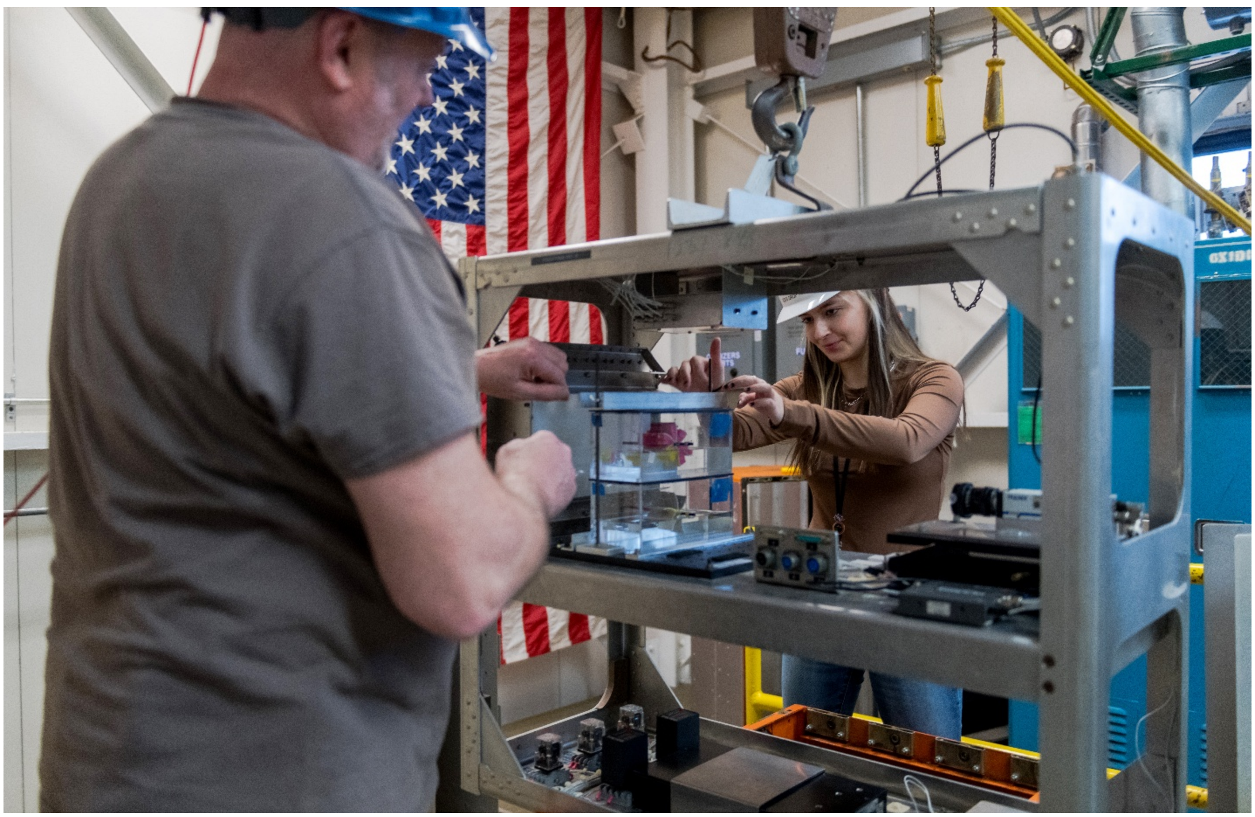

Figure 2 - Preparing for a drop on the fifth floor of the 2.2 Second Drop Tower.

Who?

This design challenge is for students in grades 8-12 from U.S. schools, including the fifty states, District of Columbia, Puerto Rico, American Samoa, Guam, the Northern Mariana Islands, the U.S. Virgin Islands, and all DoWEA schools (which are for children of U.S. military personnel). Except for the DoWEA schools, this challenge is not open to participants outside of the United States regardless of citizenship.
Teams will be favored over individuals in selection. The teams are expected to do most of the work, but may get help from adults, for example in building their test objects.

Furthermore:

1. Teams may be of any size, but a maximum of four students per team will be invited to the 2027 meeting of the American Society for Gravitational and Space Research (ASGSR).
2. Each student may belong to no more than one team.
3. Each team may submit no more than one proposal.
4. An organization (e.g., school, science center, 4-H club, Scout troop) may have many teams, but it may submit no more than two proposals to NASA. It is envisioned that no more than one proposal will be selected per organization.

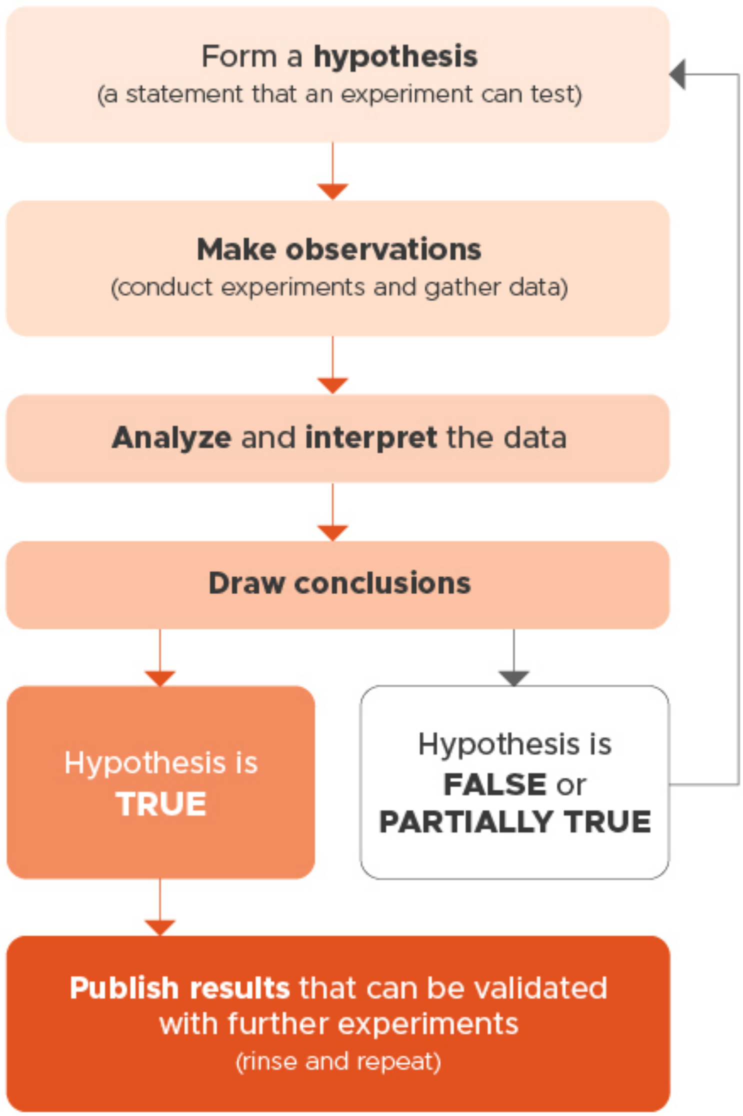

Figure 3- Scientific Method

Where?

Participation is remote, where participants do not travel to NASA for the testing. An exception is for those teams invited to present their results at the 2027 ASGSR meeting, but its location (and dates) will not be announced until Dec. 2026.

Cost?

There is no cost to participate in the challenge other than for the (1) preparation of the test objects, (2) the shipment of the devices to NASA, and (3) travel costs for those invited to present their results at the ASGSR meeting. Regarding the latter, the ASGSR has typically provided travel support of $500 each for invited non-local students who present their results at the conference.

Selection?

After proposal evaluation, NASA anticipates selecting up to 30 teams to build test objects to be tested in the 2.2 Second Drop Tower at the NASA Glenn Research Center in Cleveland, Ohio. Only a few top-performing teams will be invited to participate in the ASGSR conference.

B. THINGS TO KNOW

1. Calendar

2026	***Now!!!***	***Preparation of your proposal***
	► Mon. Oct. 26 11:59 PM	Deadline (in your time zone) to e-mail your team's proposal to NASA
	Late November	NASA announces teams selected for testing
	Mid-December	NASA provides proposal feedback to teams
2027	Jan.-February	Preparation of devices
	Fri., Jan. 15	Deadline to e-mail your team's updated and detailed materials list to NASA. You must also include updated dimensions and drawings if the size or shape of the test objects has changed.
	► Thurs., Feb. 18	Deadline for the **arrival** of your devices at NASA
	Feb.-March	Testing in NASA's 2.2 Second Drop Tower
	Late March	NASA provides access to the drop test results
	Mon., April 5	Deadline for your team to e-mail confirmation of your successful download of the drop results
	April	Analysis and report writing
	► May 1, 11:59 PM	Deadline (in your time zone) to e-mail your team's written report to NASA

	Mid-May	NASA announces teams selected for ASGSR participation
	Fall (between late Oct. and early Dec.)	Annual ASGSR meeting

Figure 4 - Drop Tower Challenge Calendar

► Failure to meet the three key deadlines will disqualify a team from being selected for ASGSR participation, if not more! This is a competition and each of these three deadlines have led to disqualifications of late teams in preceding challenges.

2. Key Rules

1. **Eligibility**
    a. The challenge is open to grades 8-12 in the United States including all fifty states, the District of Columbia, Puerto Rico, American Samoa, Guam, the Northern Mariana Islands, the U.S. Virgin Islands, and all DoWEA schools for the children of U.S. military personnel.
    b. Except for DoWEA schools, those outside of the United States are not eligible regardless of their citizenship.
2. **Team**
    a. Each team is required to have an adult advisor, who is at least 21 years old, who may advise more than one team.
    b. Teams may be of any size, but a maximum of four students per team will be invited to the 2027 meeting of the American Society for Gravitational and Space Research (ASGSR).
    c. Each student may belong to no more than one team.
    d. Each team may submit no more than one proposal.
    e. An organization (e.g., school, science center, 4-H club, Scout troop) may have many teams, but it may submit no more than two proposals to NASA.
3. **Proposals**
    a. Each team may submit no more than one proposal.
    b. An organization (e.g., school, science center, 4-H club, Scout troop) may have many teams, but it may submit no more than two proposals to NASA.
4. **Communication**
    a. E-mail and other communication with the challenge staff must be in English.
    b. The proposal and all other documents submitted to the challenge staff must be (1) in English, (2) in a .pdf format, and (3) less than 9 MB.
    c. When contacting the challenge staff, e-mail Ed-DropTower@lists.nasa.gov instead of individual staff members to avoid the chance of e-mailing someone who is vacationing, sick, etc. and not checking their e-mail.
    d. Students who directly e-mail Ed-DropTower@lists.nasa.gov must always cc: their adult advisor.
5. **Test objects**
    a. **Number:** Each team may include up to 3 devices in their proposal and if selected for testing may send NASA up to 3 test objects for testing.

a. **Free Standing:** Each test object must freely stand upright on a flat horizontal surface in normal gravity without support or attachment to the surface.
b. **Density:** The devices must not float in the water (with soap) and must remain upright on the bottom of their vessels, without attachment or support, throughout the drop.
c. **Height:** The test objects must be no more than 150 mm tall. *Note that the water with soap will be added to a height of 70 mm after the test objects are placed in their vessels.*
d. **Width & Depth:** The devices must be no more than 55 mm across, whether side to side or front to back (relative to the camera). *But they may be longer across diagonally (e.g., front left to back right), where the cross section of each water vessel is approximately square.*

6. **Prohibited materials, components, etc.**
    a. Hazardous materials that are corrosive, toxic, radioactive, etc.
    b. Chemical reactions, compressed gases, sharp edges
    c. Electrical components such as batteries, lasers, motors, pumps, etc.
    d. Fragile materials such as glass, thin plastic, etc.
    e. Materials or coatings that are liquid when shipped to NASA
    f. Materials or coatings that dissolve in or react with water, e.g., antacid tablets
    g. Parts, materials, or coatings that separate, intentionally or otherwise, from the devices and contaminate the water
    h. Small creatures, whether dead or alive, and most biological materials other than cork, cotton, leather, wood, and wool

7. **Deadlines**
    a. Late submission of the proposals, test objects, and/or written reports will disqualify teams from the competition. In other words, teams that miss any of these deadlines will not be considered for invitation to the ASGSR meeting even if they might have otherwise been considered in first place!
    b. By Friday, Jan. 15, each team shall e-mail Ed-DropTower@lists.nasa.gov with an updated and detailed materials list. That e-mail must also include updated dimensions and drawings if the size and/or shape of the devices has changed.
    c. By Monday, April 5, each team shall e-mail Ed-DropTower@lists.nasa.gov and confirm that they have successfully downloaded their drop results.

3. Hints

Follow the rules and instructions! **Read this guide to know what they are.**

Control and variables: You should have multiple test objects so that you can compare their performance in your report–-and poster too if you are selected for ASGSR meeting participation. An added benefit is the increased probability of success with the challenge.

Shaken, not stirred: The water vessels in which the test objects are placed, and the drop rig itself, will slightly tip and shake during preparations for each drop. This happens when (1) the vessels are loaded into the drop rig and (2) when the rig is hoisted to the tower's top. You may want to consider that tipping and shaking in your designs because each device must be upright on the bottom of its vessel during the drop and of course at the drop's start.

Transparent? While not required, there may be value in having transparent devices so that you can better assess their performance.

Conduct your own tests: To improve your odds of success, conduct your own tests to discover which designs work best.

Test as dropped, drop as tested: If you want to verify your designs, then you should conduct your own tests like they will be carried out in NASA's drop tower. Consider putting your devices and water/soap mixture—*in which 6 milliliters of liquid dishwashing detergent has been added per liter of water*—in a plastic jar (or similar) in a box with a video camera and dropping the box to get a glimpse of what happens in microgravity. Just a 4-foot fall provides a half second of microgravity. While that's not long, it can provide a hint of what will happen in the 79-foot fall in NASA's 2.2 Second Drop Tower. For inspiration on conducting your own drop research, check out the Fire in Free Fall video by Physics Girl Dianna Cowern. You may change the designs of your test objects after your proposal is submitted, but all rules must still be followed.

Timing is critical: Late submissions to NASA of your proposal, test objects, or written report will each disqualify your team from invitation to the ASGSR meeting. Don't wait until the deadlines to complete tasks!

4. Selection Criteria for ASGSR Meeting Participation

Teams will be evaluated based on the following:

1. Performance during testing in the 2.2 Second Drop Tower
2. Team's approach to the challenge (as revealed in their proposal and especially their written report) including their application of the:
    a. engineering design process
    b. scientific method
3. Team's analysis (as revealed in their final report)
4. Team's written report
5. Compliance with rules and instructions
6. On-time submission of the proposal, test objects, and written report

C. WHAT TO DO

There are four phases of participation in the challenge:

1. Prepare your proposal – *open to all eligible*
2. Build your test objects – *open to all teams selected by NASA for testing*
3. Analyze and document your results – *generally after the NASA microgravity testing, but some draft text can be written during the first two phases*
4. Present at the 2027 ASGSR conference – *open to those teams invited by NASA based on the selection criteria shown above*

Each phase is separated by a submission to NASA and subsequent phases rely on the earlier ones for continued participation. The proposal is used to determine whether a team will continue to phase 2 and build their devices for microgravity testing at NASA. The test objects must be submitted for testing to have results to analyze and write about in phase 3. Finally, invitation to present in the student poster session at the ASGSR meeting (phase 4) depends on the team's written report and all that preceded it.

1. Prepare your proposal

1.1 Understand the challenge

The goal is to design and build devices to suck in as much water/soap mixture as possible during free fall within NASA's 2.2 Second Drop Tower. Yes, your test objects are really supposed to suck, but they must do so because of the wetting characteristics of their surfaces and not because of suction or any mechanical means. In contrast, the mixture should not climb the exterior surface of your devices.

In preparation for the drop testing, each test object will be placed in the bottom of a plastic box (aka water vessel), after which the water-soap mixture will be added to the height of 70 mm. The NASA-prepared mixture will include 6 milliliters of liquid dishwashing detergent per liter of water.

The water vessels with a team's test objects will be loaded in the drop rig as depicted in Figures 1 and 2 (from past challenges). As the devices are loaded and the drop rig is lifted to the tower's top, the water vessels will slightly tip and shake. The drop will typically occur about 15 minutes after the water-soap mixture is added to the water vessels, but it could be a half hour or more. That is just one reason why it is important that the materials, including adhesives and any applied coatings, do not dissolve in water.

With this process, a single drop will include all the devices sent by a team to NASA for testing. Two drops for each team are envisioned but not guaranteed.

Figure 5 - Containers with objects from a past challenge being loaded into the drop rig

Scoring: For the testing, a device's score will be based on the vertical drop in the soapy water level within the plastic box and more specifically outside of the device during the 2.2 seconds of microgravity. Any fluid motion before release and at (and after) impact doesn't count. Each team's test performance is based on the greatest fluid shift achieved during free fall, as measured by the vertical change in the lowest point of the fluid's meniscus (i.e., fluid-air interface).

In scoring a team's test performance, there will be no averaging for multiple devices and/or multiple drop tests. But having multiple test objects increases the odds of a high score and allows for the comparison of results in the report.

Adhesion & cohesion: The balance between the attraction of the liquid and a surface (adhesion) and the liquid's attraction to itself (cohesion) affects how the water-soap mixture interacts with surfaces, including those on the devices.

Water loving & fearing: A surface's properties can affect liquid interactions, where their influence can be particularly strong in microgravity. Surfaces can be either hydrophilic or hydrophobic, that is 'water loving' or 'water fearing.' As an extreme example, the leaves of the Lotus flower have a superhydrophobic surface where researchers are working to mimic the 'Lotus effect.'

1.2 Become familiar with microgravity fluid physics

Before designing your devices, learn how liquids can behave in microgravity from the short video clips referenced in the Appendix B section on **Fluids in microgravity**. A suggested place to start is the *Science off the Sphere* demonstrations conducted on the International Space Station by NASA astronaut Don Pettit.

But to learn about surface wetting, see the internet content listed in Appendix B under **Capillary action, surfaces, etc.** If you want to dig deeper, consider reviewing A Researcher's Guide to International Space Station Fluid Physics.

1.3 Develop your test object concepts

Based on your research, design devices that will pull in as much water-soap mixture during free fall as possible because of the devices' wetting properties. NASA will provide the rest of the experiment hardware including the plastic boxes (each holding a test object and the water-soap mixture), the video camera, and lighting.

Number: Each selected team must propose and submit 1 to 3 three devices for testing. At least one must be proposed and assuming selection built and shipped to NASA for microgravity testing. But with multiple test objects, which can be different, a team can compare the test results in the required report and—if invited—at the 2027 ASGSR conference.

Free Standing: Each test object must freely stand upright on a flat horizontal surface in normal gravity without support or attachment to the surface.

Density: The devices must not float in the water-soap mixture and must be upright and at the bottom of their vessels after the drop rig is hosted to the tower's top. They must remain upright on the bottom of their vessels, without attachment or support, throughout the duration of the drop.

Size: This challenge will use water vessels like those depicted in Figure 2. The test objects must be no more than 150 mm tall, where you should keep in mind that the water-soap mixture will be added to a height of 70 mm. They must also be no more than 55 mm across, whether side to side or front to back relative to the camera. But they may be longer across diagonally, e.g., front left to back right (relative to the camera), where the cross section of each water vessel is approximately square. **Size matters! For example, test objects that don't fit in the water vessels won't be tested at NASA.**

Wetting: NASA will not advise your team on whether your devices should have hydrophilic (water-loving) and/or hydrophobic (water-fearing) surfaces. *In general, the challenge staff will not help teams succeed, except in broad ways such as explaining the rules and instructions.*

Materials: The devices must be fabricated from safe solid materials such as plastic or metal. Please avoid the use of fragile materials such as glass, thin plastic, etc. in your test objects. Verify the ruggedness of your devices because they must survive shipping to and handling at NASA.

Safety: Corrosive, toxic, and radioactive materials are prohibited. Other hazards such as compressed gases and sharp edges are also not allowed.

Biology: Small creatures (such as insects) are not allowed, whether they are dead or alive. Other biological samples are generally not allowed, but materials such as cork, cotton, leather, wood, and wool are allowed exceptions.

Chemistry: Chemical reactions are prohibited, so avoid materials and coatings that react with water (such as antacid tablets).

Electricity: Electrical components such as batteries, lasers, motors, pumps, etc. are not allowed, but wire is an allowed exception.

Insoluble: Materials, including coatings, must not dissolve in water.

Liquids: While liquids can be used in creating your test objects, they must be dry, not sticky, and contain no liquids when they are shipped to NASA.

Separation: The devices may not include parts, materials, or coatings that separate, intentionally or otherwise, in the water. As examples, (1) the fluid must not become cloudy or discolored, and (2) the wetting of the water vessels must not be affected by contamination from the devices. **Devices causing such outcomes will receive zero in test performance scoring regardless of the resulting fluid shift.**

Variables: The difference between devices should be limited so that you can learn what caused differences observed in testing. If you have two test objects that differ in multiple ways, how will you know which differences matter and how important those are to the fluid shifts seen in testing? But if there is only one difference between a pair of objects, the cause of different test results becomes clear. In this regard, the challenge is not just to suck in as much of the water-soap mixture as possible. Through the challenge, you should learn at least one way to pull in more of the mixture.

1.4 Prepare and submit your proposal

Prepare your proposal using the entry form, shown in Appendix C, which is available online as a stand-alone file. The proposal shall include information about your team plus descriptions and drawings of your envisioned test objects. The drawings must include their dimensions. The proposal must be written in English and consist of a single file, in a pdf format, into which all figures must be *pasted*. The file must be less than 9 MB in size or it will not be received by the challenge staff.

E-mail the proposal to Ed-DropTower@lists.nasa.gov by no later than Monday, Oct. 26, 2026. More precisely, your proposal must be e-mailed to NASA before midnight (i.e., by no later than 11:59 PM) in your local time zone. The proposals will be reviewed, and selections will be announced via e-mail to all proposers by late November. Teams selected for testing may continue to the next phase.

2. Build your test objects

Assuming that your team is selected for participation in the testing, build your devices following the rules in the design section (1.3) of this guide. Make sure to review the key rules and hints during your design.

SAFETY: Please follow directions for the safe use of materials and equipment in fabricating your test objects. Similarly, make sure that any preliminary testing is carried out safely.

It is highly recommended that you conduct your own microgravity trials: Consider mounting your devices in a plastic jar (or similar) in a box with a video camera and dropping the box to get a glimpse of what happens in microgravity. Just a 4-foot fall provides a half second of microgravity. While that's not long, it can provide a hint of what will happen in the 79-foot fall in NASA's 2.2 Second Drop Tower. But note that there is a diminishing return with height. Fall times of 0.5, 1.0, and 1.5 seconds respectively require drops of 4, 16, and 36 feet. Given that risks can increase with height, consider that only modest gains in test duration are achieved with heights beyond a second story.

For inspiration on conducting your own drop tests, check out the Fire in Free Fall video by *Physics Girl* Dianna Cowern. You can also contact Ed-DropTower@lists.nasa.gov for guidance.

Changes: It is acceptable to change your designs, e.g., based on research conducted after your proposal submission, provided that all challenge rules are still met. As such, you are encouraged to check with Ed-DropTower@lists.nasa.gov to ensure that the new designs are acceptable. Given the Feb. 18 deadline for the arrival of your test objects at NASA, you should strive to finalize your designs in January.

Materials, dimensions, and drawings update: Each team is expected to e-mail the challenge staff by Jan. 15 at ed-droptower@lists.nasa.gov with an updated list of all materials used in your devices. In that list, clearly identify any materials that were not listed in your initial proposal. If there are changes to designs, even just the dimensions, updated drawings must be submitted. Updated drawings are also required if the number of test objects is changed. But updated drawings are not required if the change(s) are limited to the materials, e.g., coatings. This update will be requested in early January to ensure that safety requirements will be met during drop testing at NASA.

Extra test objects: You may want to make extra copies of your devices to keep because the ones sent to NASA won't be returned. For example, you could display extra copies at your school or perhaps show them at the ASGSR conference.

Liquids: When shipped to NASA, all test objects must be dry, not sticky, and not contain liquid. But your team can use liquids, including coatings, in preparing your devices. The devices, including any coatings, just need to be dry when they are shipped.

Coatings: Coatings must be applied by your teams before the test objects are shipped to NASA. Coatings—and all other materials—must not (1) dissolve in water, (2) react with water, or (3) detach from your devices in the water-soap mixture.

Packaging: Once your test objects are ready, package them to prevent breakage during shipping and injury to challenge staff. Although a team's devices should be shipped together in one package, each one must be packaged individually in its own resealable plastic bag that is labeled with a permanent marker with the following:

1. **Team identification:** FS27_<StateAbbrev>_<OrgAbbrev>_<AdvisorLastName>_<TeamAbbrev>
2. **Device number, letter, etc.** (for example: 1 or A)
3. **Device orientation:** If your device(s) are not symmetric and you have a preferred orientation relative to the camera, indicate "preferred orientation enclosed" or instead "no preferred orientation." See the Orientation discussion below for more information.

An advisor with two selected teams may ship both sets together to NASA, making such labeling even more important.

Note that the shipment of more than three devices by a team is unacceptable even if more were built. **Each team must choose no more than three test objects to ship to NASA.**

Orientation: If you have a preferred orientation for device(s) relative to the camera, include sheet(s) of paper explaining your preference, for example through drawing(s). Again, this information should be on paper identifying the test object (by its number, etc.) that is also labeled:

FS27_<StateAbbrev>_<OrgAbbrev>_<AdvisorLastName>_<TeamAbbrev>

As stated earlier, if you have no preferred orientation for a device, e.g., because of its symmetry, then label its resealable plastic bag with "no preferred orientation."

Shipping: Ship the test objects and documentation described above to the following address, where they must **arrive** **at NASA by no later than February 18, 2025**.

Fluid Shift c/o Nancy Hall – DESK
NASA Glenn Research Center
21000 Brookpark Road, Bldg. 77, Rm. 238
Cleveland, OH 44135

Teams who ship devices that arrive late will be disqualified from the competition!

Given the delivery requirement, we recommend that you use a shipper that will provide tracking information such as FedEx, UPS, or USPS (United States Postal Service), where those shippers are simply listed alphabetically. To be clear, these are suggestions and are not meant as endorsements. We cannot advise you on the time required for delivery from your location; that is your responsibility.

3. Analyze and document your results

3.1 Draft written report

Report writing can and ideally should begin after your team's proposal has been selected for testing. Even before the drop tests are conducted at NASA, your team can begin writing an introduction based on what you've learned in preparing your proposal and from any preliminary tests performed by your team. References can also be documented. You can also draft the section describing your experiment (i.e., attempt at the challenge) once the design of your devices has been finalized. You can write about any preliminary testing you conducted, including both how you did it and what you learned. But of course, you'll need to wait until the tests at NASA have been conducted to write up those results and your conclusions. Furthermore, the abstract should be the last section of your paper to be written.

Science: While *Fluid Shift* is a design challenge in which you must apply engineering skills, the report should be prepared as a scientific paper that might be presented at a technical conference or published in a journal. Such papers contribute to the advancement of science because they describe in detail what was both done and learned. The details allow readers to duplicate the described tests and verify or challenge the presented findings. Other researchers can't check your results if your paper doesn't sufficiently explain your devices to allow readers to make their own copies. Similarly, your paper should explain the testing, including that conducted at NASA, and your measurements.

Format: There is no required format for the written report, but it should not be prepared like a school lab report. As two examples, it should not have a cover page and it should not have photos of team members, unless for example to show how at-home testing was conducted. As another example, your team's name (if any) shouldn't appear in your written report. Instead, it is suggested that teams generally follow the guidance found in "A Guide to Writing a Scientific Paper: A Focus on High School Through Graduate Level Student Research" by Renee A. Hesselbach et al.

Example papers: While the paper referenced in the preceding paragraph provides guidelines, you're encouraged to review a few scientific papers, for example from the open-access *Gravitational and Space Research* journal, to get an idea of how you might prepare your report. You can also freely explore the digital repository for the meetings of the International Conference on Environmental Systems (ICES), which addresses life support systems and other human spaceflight topics. At both the journal site and conference repository, you can search (e.g., for fluid, liquid, or water) and see/download the full papers.

Title: Your report's title should **not** include any of the following: NASA, 2027, Challenge, or Drop Tower Challenge. Your research paper (not lab report) shouldn't be about the challenge, but instead about the fluid science that you learned in facing the challenge. In choosing your title, consider your hypothesis (if any), variable(s), and what you learned.

Authors: While student names should not be included in your proposal, they should be included in your written report and on the poster too if your team is invited to present at the ASGSR meeting. Similarly, identify your team's organization if formal (e.g., school name) and where your team is located, but just the city and state (for example) but not the full address. This is where you should be recognized for your work!

This is a student challenge and while advisors can review and make editorial suggestions to the paper, they are not meant to be authors and should not be identified as such. But their contributions can certainly be recognized in the acknowledgements.

Audience: The paper should be written for readers who don't know anything about the *Fluid Shift* challenge, microgravity fluid behavior, or wetting phenomena (e.g., hydrophilic and hydrophobic surfaces).

Numbering: All images should be numbered, e.g., Figure 1, and have captions. Tables should similarly be numbered and have a title.

Plots: Graphs of results must have axes labeled and units identified in ways that are reasonably easy to read. Ideally results should be presented in ways that facilitate their comparison, for example between the devices or drop tests. That could be done with side-by-side graphs with axes with the same vertical ranges, although an even better option is to put the results to be compared on the same graph, for example using different symbols and/or colors to differentiate them.

Results & Conclusions: Through the text, figure(s), and/or table(s), your paper should share what you learned from your work, for example from a comparison of the results from your devices and/or drop tests.

It must be emphasized that the ranking and selection of the teams for invitation to present at the 2027 ASGSR meeting is not based on the performance in the drop tests alone. The analyses, written reports, etc. are also important factors. As a result, the team with the best test performance will not necessarily be the first-place winner or even necessarily invited to the conference.

3.2 Analyze results

NASA's goal is to electronically provide the test data to all teams by at least April 1, so if you don't receive access to your results by then, contact Ed-DropTower@lists.nasa.gov. For each test, the data will consist of a video filmed at a minimum of 30 frames per second showing what happened during the drop test(s), possibly supplemented by still images taken from the video.

Tracker, which is shared by Open Source Physics as "a free video analysis and modeling tool [for] physics education," is a suggested way to make measurements of motion in the tests. The Tracker software has notably been used by some participants in past drop tower challenges. As an alternate, many of NASA's microgravity researchers use ImageJ or its *batteries-included* version called Fiji, which are both freely available for making such measurements. That software, however, was developed for researchers and may require more time to learn.

Position measurements can also be made with simple graphic software that continually reveals the position of the cursor. Simply load an image, move the cursor to each desired position and write down their values (i.e., by hand). Repeat with successive video frames to track positions as a function of time. Microsoft Paint is an example of such software, where it reveals the position of the crosshairs in the bottom left of the window (in pixels and relative to the image).

Even more simply, measurements can be made manually by taping a transparent overlay to your computer monitor and marking the positions using a permanent marker. You can make measurements for multiple images (i.e., times) using the same transparency, where it would likely be helpful to mark each position with the image number (or time).

Please understand that these are just suggestions and are not meant to indicate endorsements by NASA or the federal government.

3.3 Complete and submit written report

Using the results from the testing, complete your written report (as described in section 3.1) and e-mail it to Ed-DropTower@lists.nasa.gov by no later than May 1, 2027, more specifically by 11:59 PM in your local time zone. Note that the report must be written in English, no more 9 MB, and submitted in a pdf format.

Please name the pdf of your report in a similar format as the proposal, specifically as FS27_<StateAbbrev>_<OrgAbbrev>_<AdvisorLastName>_<TeamAbbrev>_paper; an acceptable example is FS27_WV_GWHS_Smith_Team1_paper.

D. PRESENTATION AT ASGSR CONFERENCE

Based on their performance in the drop testing, application of the engineering design process and scientific method, analysis, and written reports, some teams will be invited in mid-May to present their results in a poster session at this annual meeting. All participating teams will be contacted by e-mail about the selections.

When and where? The meeting dates and location have not yet been announced, but it is expected that the conference will be held in late October, November, or early December. The student day will be on a Saturday, but not on Thanksgiving weekend.

Cost: It is expected that there will be a nominal registration fee, such as $75 each, for the participation of the students, advisors, and chaperones in the student day (only). Except for the continental breakfast, the admission does not include meals, but tickets may be purchased for the Saturday evening banquet.

Travel support: It is expected that financial support will be provided to help invited non-local teams travel to the conference. The expected travel support is $500 per invited student presenting at the conference. Given that the travel expenses could exceed that value, teams coming to the conference will need to take action to address the likely shortfall. Furthermore, the financial travel support will not be provided in advance. Instead, it will probably be provided as a check to the advisor at the conference.

Poster: The posters are pinned up on vertical boards and are typically no more than 48" wide and 48" tall, but the size specifications for the 2027 meeting are not yet known. The posters are almost always printed in a single piece (where software such as PowerPoint allows for custom sizes) and brought rolled up in a tube. To be clear, there will not be tables for the poster session so you should not have a tri-fold display board as might be used at a school science fair. There are many online resources with recommendations for creating and presenting scientific posters, where these are a few examples:

- 10 simple rules for designing a scientific poster
- Conference presentations: Lead the poster parade
- Creating Anthropology Conference Posters: A Guide for Beginners
- Designing conference posters
- How to Create a Research Poster
- How to make an academic poster
- Poster Perfect
- Ten Simple Rules for a Good Poster Presentation

ASGSR awards will be given based on poster presentations, where other students will be presenting on projects other than the drop tower challenge. So, this is another opportunity to do your best! The challenge participants will only be judged against other middle and high school students.

Activities: The conference will include opportunities for students to tour the exhibit hall, attend research presentations, and interact with other students, the challenge staff, and researchers from NASA and universities, etc.

APPENDIX A – FAQs: Frequently Asked Questions

Q: How are microgravity conditions created?
A: During its fall in NASA's 2.2 Second Drop Tower, each object behaves as if there is no gravity, just as if it were in orbit on the International Space Station (ISS). Our sensation of gravity and weight comes from a resistance to its pull, for example because of the floor preventing us from falling. If we are freely falling (e.g., after jumping off a diving board), we feel weightless, and free-fall is the basis for many amusement-park rides. This occurs because all objects fall at the same acceleration unless acted upon by another force. As one result, the astronauts and the ISS fall together (around the Earth) such that the astronauts float within the space station. This happens even though the space station is so close to the Earth that gravity is only about 10% less than that at the Earth's surface.

Q: Can students be on more than one team?
A: No.

Q: Can a team submit more than one proposal?
A: No. Your organization (e.g., school, club, Scout troop, etc.), however, can have multiple teams but it may submit at most 2 proposals to NASA. A school, for example, could select the top 2 proposals to submit to NASA for evaluation.

Q: Can home schools participate?
A: Yes; teams don't need to be affiliated with a school and can be formed from any group of youth in grades 8-12 including siblings, neighbors, and friends as a few examples.

Q: Can teams from countries other than the United States participate?
A: No, unless your team is from a DoWEA school for the children of U.S. military personnel. All other students from outside of the USA are not eligible, even if they are U.S. citizens.

Q: Can team members be 18 years old?
A: Yes. There is no age requirement for team members; they simply must be in grade 8-12 during the school year. Depending on birthdates, etc., it is understandable that some high school seniors will be 18 and possibly even turn 19 before the end of the school year.

Q: Is there a minimum age for the team's adult advisor?
A: Yes. The minimum age is 21.

Q: Where do we get the entry form?
A: Online, at the challenge webpage.

Q: Can proposals, reports, etc. be submitted in a language other than English?
A: No! They will be rejected, where the challenge staff doesn't have the language skills or resources to appropriately address the challenge in other languages.

Q: Are drawings required for the proposals?

A: Yes; your proposal must include descriptions and drawing(s) of each device, although duplicate drawings are not necessary if the size and shape of your devices are identical. The maximum dimensions must be identified with dimensions on the drawings. They can be drawn by hand, with standard software (e.g., PowerPoint), or using Computer Aided Design (CAD). The drawing(s) must be 'pasted' into the proposal, so that the proposal consists of a single file.

Q: What file formats are acceptable for the proposals and written reports?
A: Your proposal and written report must each be submitted as a pdf file. Teams submitting those documents in another file format risk rejection.

Q: What is the maximum file size for the proposals and written reports?
A: Each proposal's file must be less than 9 MB or it will not be deliverable to the challenge staff.

Q: Does the number of test objects proposed affect the odds of selection?
A: Yes; preference will be given to plans with multiple test objects because their results can be compared in the report.

Q: Can we make our devices using a 3-D printer?
A: Yes.

Q: Can we simply buy our test objects?
A: Yes.

Q: Will we get our devices back?
A: No. Therefore, you might want to make duplicates so that you have copies for your own presentation(s), display, etc.

Q: Will NASA help us with ideas for our proposal?
A: No.

Q: Will NASA provide guidance for our devices if we are selected to participate in the microgravity testing?
A: No, except for reminders, clarifications, etc. about the rules and instructions. Otherwise, the challenge staff won't help teams succeed. The competition isn't over until the winners are invited to present their results at the ASGSR meeting.

Q: Will NASA provide guidance on conducting our own preliminary drop tests?
A: Yes.

Questions? If you can't find the information you need in the guide or at the challenge website, e-mail Ed-DropTower@lists.nasa.gov.

APPENDIX B – Suggested Internet Links

Key links

ASGSR
https://asgsr.org/
Current Drop Tower Challenge
https://www.nasa.gov/glenn/glenn-expertise-space-exploration/physical-sciences-program/education-and-outreach/current-drop-tower-challenges-and-competitions/
Past Drop Tower Challenges
https://www.nasa.gov/glenn/glenn-expertise-space-exploration/physical-sciences-program/education-and-outreach/past-drop-tower-challenges-and-competitions/

Microgravity & drop testing

2.2 Second Drop tower
https://www.nasa.gov/centers-and-facilities/glenn/2-2-second-drop-tower/
Brian Cox visits the world's biggest vacuum (video)
https://www.youtube.com/watch?v=E43-CfukEgs
Fire in Free Fall (*video*)
https://www.youtube.com/watch?v=VAA_dNq_-8c
Microgravity (*video*)
https://www.youtube.com/watch?v=GSLwvtF4Zo0
What is Microgravity?
https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-microgravity-58.html
Zero Gravity Research Facility
https://www.nasa.gov/centers-and-facilities/glenn/zero-gravity-research-facility/
Zero Gravity [Research] Facility (*virtual tour*)
https://www.nasa.gov/glenn/virtual-tours/zero-g/

Fluids in microgravity (*all videos unless otherwise noted*)

4K Camera Captures Riveting Footage of Unique Fluid Behavior in Space Laboratory
https://www.youtube.com/watch?v=Vx0kvxqgC1c
4K Video of Colorful Liquid in Space
https://www.youtube.com/watch?v=bKk_7NIKY3Y
A Cup of Joe in Space
https://www.youtube.com/watch?v=8sDc00IK7mA
A Researcher's Guide to International Space Station Fluid Physics (*booklet*)
https://www.nasa.gov/wp-content/uploads/2019/10/iss-fluid_physics_tagged.pdf
Behaviour of water in microgravity
https://www.youtube.com/watch?v=HjBU_4if_CE
Boiling Fluids Behave Quite Differently in Space
https://www.youtube.com/watch?v=kdt20h0ZaDw
Capillary Flow Experiments on Space Station
https://www.youtube.com/watch?v=3lwy8xxJxKo

Christa's Lost Lessons: Liquids in Microgravity
https://www.youtube.com/watch?v=HGf4Uka5hac
Honey in space
https://www.youtube.com/watch?v=Say3pUbllSA
ISS Update: Capillary Flow Experiments-2
https://www.youtube.com/watch?v=K-PQE-VEdhc
Liquid Ping Pong in Space - RED 4K
https://www.youtube.com/watch?v=TLbhrMCM4_0
Moving Water in Space - 8K Ultra HD
https://www.youtube.com/watch?v=H_qPWZbxFl8
Open Science: Space Coffee Cup
https://www.youtube.com/watch?v=Kr3OPNjsx_M
Playing with water in space!
https://www.youtube.com/watch?v=Z2Jh9KyvJqg
Science off the Sphere: Astro Puffs
https://www.youtube.com/watch?v=e6Faq1AmISI&t=8s
Science off the Sphere: Fun with Antibubbles
https://www.youtube.com/watch?v=U9VFwGYRZQg&t=69s
Science off the Sphere: Bistronauts
https://www.youtube.com/watch?v=q1k9njdSVE0
Science off the Sphere: Goo!
https://www.youtube.com/watch?v=Ohs8TQxDuX8&t=117s
Science off the Sphere: Knitting Needle Experiment
https://www.youtube.com/watch?v=qHrBhgwq__Q&t=101s
Science off the Sphere: Lenses and Vortices
https://www.youtube.com/watch?v=CrTUpTDyGpI&t=103s
Science off the Sphere: Space Balloonacy
https://www.youtube.com/watch?v=WIsydeu7ZTo&t=78s
Science off the Sphere: Space Soundwaves
https://www.youtube.com/watch?v=U0rl_-z1YwQ&t=175s
Science off the Sphere: Thin Film Physics
https://www.youtube.com/watch?v=Uddz-3RwA_Y&t=1s
ScienceCasts: Space Coffee
https://www.youtube.com/watch?v=dWuEVSCw8B8
Sciencetasia (*also addresses plants and flames in microgravity*)
https://www.youtube.com/watch?v=dZpTaC_SP_4
Scientists popping water balloons in weightlessness (microgravity)
https://www.youtube.com/watch?v=u7TQM9z2IJA
Space Station Live: A Cup of Coffee Beats a Bagful
https://www.youtube.com/watch?v=Fttaf_rhpm4
Space Station Live: ISS: Space Cup Full of Science
https://www.youtube.com/watch?v=0Lmsvr8VVwM
SpeedyTime 5 – Water in Space
https://www.youtube.com/watch?v=NmnnBvYFOIs
STEMonstrations: Properties of Water
https://www.youtube.com/watch?v=4A_dMWsw2oA

STEMonstrations: Surface Tension
https://www.youtube.com/watch?v=34bFgA3H3hQ
Tears in Space (Don't Fall)
https://www.youtube.com/watch?v=P36xhtpw0Lg
Water and Ping Pong Ball - Microgravity Experiment
https://www.youtube.com/watch?v=hI8fg_d67fU
Water Glove in Space
https://www.youtube.com/watch?v=aD1D9E_tdS8
Why Is NASA Boiling Fluids in Space?
https://www.youtube.com/shorts/O1gj-MMjtqc
Wringing out Water on the ISS - for Science!
https://www.youtube.com/watch?v=o8TssbmY-GM

Capillary action, surfaces, etc.

Capillarity – Measuring Surface Tension
https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less2
Capillary Action and Water
https://www.usgs.gov/special-topics/water-science-school/science/capillary-action-and-water
Explained: Hydrophobic and Hydrophilic
https://news.mit.edu/2013/hydrophobic-and-hydrophilic-explained-0716
Fundamentals of Surface Tension/Wettability
http://web.mit.edu/nnf/education/wettability/index1.html
Lotus effect
https://www.kruss-scientific.com/en/know-how/glossary/lotus-effect
Superhydrophobic surfaces
www.lawrencehallofscience.org/sites/default/files/pdfs/college_resources/modules/Superhydrophobic/Superhydrophobic_Surfaces.pdf
Superhydrophobicity – The Lotus Effect
https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less4
Surface Tension Basics
https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less1
Wetting and Contact Angle
https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less3

Analysis software

Fiji
https://fiji.sc/
ImageJ
https://imagej.net/ij/
Tracker
https://opensourcephysics.github.io/tracker-website/

Paper writing

A Guide to Writing a Scientific Research Paper
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3528086/pdf/zeb.2012.0743.pdf
Gravitational and Space Research journal
https://reference-global.com/journal/GSR
International Conference on Environmental Systems (ICES) digital repository
https://hdl.handle.net/2346/58495

Poster guidance (*e.g., for those invited to present at the ASGSR meeting*)

10 simple rules for designing a scientific poster
https://www.molecularecologist.com/2016/06/03/10-simple-rules-for-designing-a-scientific-poster/
Conference presentations: Lead the poster parade
https://www.nature.com/articles/nj7614-115a
Creating Anthropology Conference Posters: A Guide for Beginners
https://content.csbs.utah.edu/~cashdan/tig/making_a_poster.pdf
Designing conference posters
https://colinpurrington.com/tips/poster-design/
How to Create a Research Poster
https://guides.nyu.edu/posters/
How to make an academic poster
https://www.ovid.com/jnls/annals-of-medicine-and-surgery/fulltext/10.1016/j.amsu.2016.09.001~how-to-make-an-academic-poster
Poster Perfect
https://www.the-scientist.com/poster-perfect-42000
Ten Simple Rules for a Good Poster Presentation
https://pmc.ncbi.nlm.nih.gov/articles/PMC1876493/pdf/pcbi.0030102.pdf

Microgravity on aircraft (*selected videos for related fun & enlightenment*)

OK Go - Upside Down & Inside Out
https://www.youtube.com/watch?v=LWGJA9i18Co
OK Go - Upside Down & Inside Out BTS - How Parabolas Work
https://www.youtube.com/watch?v=bMrX014HTgU
OK Go - Upside Down & Inside Out BTS - How We Did It
https://www.youtube.com/watch?v=pnTqZ68fl7Q&t=2s

Please understand that these are just suggestions and are not meant to indicate endorsements by NASA or the federal government.

APPENDIX C – Entry Form

The form can be downloaded from the 2027 Drop Tower Challenge webpage.

This entry form must be completed in English; the use of other languages is unacceptable. The entry form consists of 4 key parts: Participant Information, Experiment Information, Drawings and Checklist.

PARTICIPANT INFORMATION		
A	**Adult advisor name**	
B	**Adult advisor e-mail address**	
C	**Team type (choose one)** **Formal: [school, club, troop, etc.]** **Informal: [friends, family, solo]**	
D	**Team organization name** **(*only for formal teams*)**	
E	**School(s) of the team members**	
F	**City (or township, etc.)**	
G	**State or territory (etc.)**	
H	**Student grade level(s) [8 9 10 11 12]**	
I	**Number of students on the team**	
J	**Team name (*if any*)**	
K	**How did you learn of the drop tower challenge?**	

19Notes

A-B All teams are required to have an adult advisor, who is at least 21 years old, such as a teacher, group leader, parent, or guardian.

C Formal teams are typically advised by a teacher, staff member, or volunteer leader of the organization. In contrast, informal teams are typically advised by a parent or guardian of one of the team members. Appropriate entries include school, club, troop, science center, friends, family, solo, etc.

D Name of the team's organization, e.g., the school (whether public, private, or home), club (whether school or otherwise), Scout troop, science center, etc. This only applies to formal teams, which are typically advised by a teacher, staff member, or volunteer leader of the named organization.

E Name of the school(s) which the team members attend.

F-G For formal teams, specify the city and state (or territory, etc.) of the organization. For informal teams, use the advisor's city and state (etc.).

H The challenge is open to team members in grades 8-12, where selection preference will go to teams over individuals. Multi-grade teams, as might be found in a club or family, are acceptable.

J The optional team name can, but doesn't need to, match that of your school mascot, etc. This is an opportunity to be creative.

While the proposal must include contact information for the adult advisor, it must otherwise <u>not</u> include student names or contact information.

EXPERIMENT INFORMATION		
1	**Experiment name**	
2	**Research question**	
3	**Hypothesis (optional)**	
4	**Number of test objects (max 3)**	
5	**Materials from which the device(s) will be fabricated, including any coatings, adhesives, etc.**	
6	**Device 1 max dimensions (in mm)**	
7	**Device 2 max dimensions (in mm)**	
8	**Device 3 max dimensions (in mm)**	
9	**How will the devices (if 2 or 3) differ in NASA testing?**	
10	**How will the devices (if 2 or 3) be the same in NASA testing?**	
11	**Analysis plan (optional)**	

Notes

1 NASA and other researchers sometimes create names describing their experiments that can be abbreviated in a meaningful or interesting way. For example, a fluids experiment conducted on the International Space Station featuring liquid crystals was named *Observation and Analysis of Smectic Islands in Space* (OASIS), where smectic describes a parallel arrangement of liquid crystals. Meanwhile, a space shuttle investigation was named Enclosed Laminar Flames (ELF). But you don't need an abbreviation and are free to name your experiment as you'd like. Your investigation's name will not be used in the selection process unless it is offensive.

2 The research question should be specific to the test objective, for example related to the difference(s) between the test objects (if there are two or three). Generic research questions, such as "which device will pull in the most fluid?" or 'how much fluid will the device suck" are inappropriately vague.

3 The hypothesis should address the research question.

4 The experiment should include two or three test objects to allow for the comparison of results.

5 To the best of your ability, clearly identify all materials from which the envisioned test objects will be made including any coatings, adhesives, fasteners, etc.

6-8 Identify the maximum dimensions, e.g., height and width, in millimeters (mm). The dimensions and your designs can be changed later provided that the rules are still met.

7-8 Skip if you have fewer test objects.

11 A brief description of an analysis plan is optional and will not be used in the selection process.

DRAWINGS

Orthographic: Orthographic drawings (e.g., of the front, side, and top views), explained for example at https://www.youtube.com/watch?v=SdLegfoMXNA, of each of your devices are required. Hidden features can be shown with dashed lines or with section view drawings, for example as discussed at https://draftaid.io/blog/section-view-drawings/.

Note that only two views (e.g., orthographic projections) are required for symmetric devices that appear the same from both the front and side. Duplicate drawings are also not required if you plan to have devices that are the same except for their materials, for example their coatings.

Dimensions: The maximum dimensions, e.g., height and width, of each test object must be labeled in millimeters on the orthographic drawings.

3D: You may additionally include three-dimensional (3D) drawing(s), but they are not required. One approach is isometric drawings, e.g., as explained at https://sketchplanations.com/isometric-projection.

Labeling: Each drawing must identify the device (or devices) that it represents, for example by number(s) or letter(s).

Drawing: The drawings can be (1) drawn by hand and scanned or photographed, or (2) they can be created on the computer, e.g., using software such as MS Paint or PowerPoint. Computer-Aided Design (CAD) drawings are acceptable but are not required.

Pasted: The drawings must be pasted (or otherwise merged) into this entry form (below and/or on subsequent blank pages), where attaching them as separate file(s) is unacceptable.

File: There is no limit to the number of drawings and pages that may be included in the entry, but the resulting entry form file must be submitted via e-mail (1) in English, (2) in a pdf format, (2) and less than 9 MB. Larger files will not be received by the challenge staff, which of course interferes with selection.

KEY RULES CHECKLIST (*See the guide for other key rules.*)

- □ Participants must be grade 8-12 students in the United States (incl. territories) or DoWEA schools.
- □ A student may only be on 1 team.
- □ Teams can be of any size, but a maximum of four students per team will be invited to the ASGSR meeting.
- □ A team may only submit 1 entry.
- □ An organization (e.g., school) may submit no more than 2 entries.
- □ Each team must have 1-3 test objects in their proposal.

SUBMISSION CHECKLIST

This entry form must …

- □ be in English, where use of other languages is unacceptable
- □ include orthographic drawings of each device in which:
  - □ each drawing is identified by the device number, letter, etc.
  - □ maximum dimensions (e.g., height and width) are clearly labeled in millimeters
- □ be submitted in a .pdf format (where all other formats are unacceptable) named FS27_<StateAbbrev>_<OrgAbbrev>_<AdvisorLastName>_<TeamAbbrev>_entry, where an acceptable example file name is FS27_WV_GWHS_Smith_Sailors_entry.pdf

  The abbreviations for eligible states, territories, etc. are provided on the next page for reference. The team abbreviation can be the team's name (if short) or initials or some other short designator. If an organization submits two entries (the maximum allowed), the team abbreviations must be different.
- □ be less than 9 MB in size (where, in contrast, there is no limit to the number of pages)
- □ be e-mailed to Ed-DropTower@lists.nasa.gov no later than Monday, Oct. 26, 2026, 11:59 pm (your local time)

  The adult advisor must be cc'd with the submission e-mail or instead personally submit it on behalf of the team. If an advisor oversees two teams, their proposals must be e-mailed separately.

STATE, ETC. ABBREVIATIONS

U.S. State	Abbrev.	U.S. State	Abbrev.	U.S. State	Abbrev.	U.S. Territory	Abbrev.
Alabama	**AL**	Louisiana	**LA**	Ohio	**OH**	American Samoa	**AS**
Alaska	**AK**	Maine	**ME**	Oklahoma	**OK**	District of Columbia	**DC**
Arizona	**AZ**	Maryland	**MD**	Oregon	**OR**	Guam	**GU**
Arkansas	**AR**	Massachusetts	**MA**	Pennsylvania	**PA**	Northern Mariana Islands	**MP**
California	**CA**	Michigan	**MI**	Rhode Island	**RI**	Puerto Rico	**PR**
Colorado	**CO**	Minnesota	**MN**	South Carolina	**SC**	U.S. Virgin Islands	**VI**
Connecticut	**CT**	Mississippi	**MS**	South Dakota	**SD**	DOWEA schools	**DOW**
Delaware	**DE**	Missouri	**MO**	Tennessee	**TN**		
Florida	**FL**	Montana	**MT**	Texas	**TX**		
Georgia	**GA**	Nebraska	**NE**	Utah	**UT**		
Hawaii	**HI**	Nevada	**NV**	Vermont	**VT**		
Idaho	**ID**	New Hampshire	**NH**	Virginia	**VA**		
Illinois	**IL**	New Jersey	**NJ**	Washington	**WA**		
Indiana	**IN**	New Mexico	**NM**	West Virginia	**WV**		
Iowa	**IA**	New York	**NY**	Wisconsin	**WI**		
Kansas	**KS**	North Carolina	**NC**	Wyoming	**WY**		
Kentucky	**KY**	North Dakota	**ND**				

QUESTIONS

If you still have questions after checking the entry form, guide, and challenge website, then e-mail the challenge staff at Ed-DropTower@lists.nasa.gov.