# *HOW-TO GUIDE*

## Challenge overview

- **What?** Teams of grade 9-12 students are challenged to design and build simple objects that will submerge in water as far as possible when exposed to a microgravity environment in the 2.2 Second Drop Tower [1] at the NASA Glenn Research Center [2] in Cleveland, Ohio. Selected teams will compete in the challenge and are strongly encouraged to present their results at the American Society for Gravitational and Space Research (ASGSR) conference in Seattle, WA.
- **Who?** The design challenge is for students in grades 9-12, where teams will be favored over individuals in selection. Youth are free to get help from adults, for example in building their experiment hardware. An organization (e.g., school, science center, 4H club, Scout troop) may submit no more than five proposals, where it is envisioned that no more than two will be selected from a single organization.

  **Selection?** For this challenge, NASA anticipates selecting 10 teams local to Seattle (i.e., within a few hours' drive) and 10 non-local teams. Limited financial travel support will be provided to selected non-local teams who present on their research at the Seattle conference.

## How does a team participate?

- **Engineering**
  - **Watch the video** –
    - Watch the YouTube video on *Ping Pong Ball On Water* [3] that shows an experiment created by a middle school team for a previous drop tower competition. The DIVER challenge goal is for student teams to create an object that will float under normal-gravity conditions but dive into the water during microgravity conditions.
    - When an object is floating on water in normal gravity, an upward force is exerted by water that opposes the weight of the less dense object. However, in microgravity, there is effectively no weight and the interaction between the object and the water is governed by the contact angle or wettability of the object by the water. Thus, to submerge the object for this challenge, it is necessary to increase the wettability of the object. However, note that the objects must float in water in normal gravity or they will not be accepted for testing.
  - **Design & build diving object** – Next, design your own object(s) that will submerge during the free fall. Note that NASA will provide the rest of the experiment hardware including three containers (each holding water and a team's object), the video camera, and lighting.
    - **Number** - Participating teams can submit up to three different objects for testing. This will allow for a comparison of results.
    - **Materials** – The diving objects must be fabricated from safe solid materials such as plastic or metal. Glass and similarly fragile materials are unacceptable.

Corrosive, toxic, and radioactive materials are prohibited. Hazards such as sharp edges, compressed gases, batteries, and lasers are not allowed. Biological samples such as insects are also not allowed with the exception of wood.
    - **Containers** – Each diving objects will be tested in its own identical chamber with water. These rectangular containers will each be 210 mm tall and 63 mm on a side. Three containers with objects will be tested in a single drop.
    - **Size** – The longest dimension of each object shall be no more than 60 mm and no less than 5 mm.
    - **Buoyant** – Each object shall float in water while in normal gravity or it will be rejected (e.g., from testing).
    - **Diving** – Objects may only dive because of their wetting characteristics and must not dive because of other reasons, e.g., mechanical propulsion initiated during free fall, etc.
  - **E-mail proposal** to celere@lists.nasa.gov including the conceptual designs of your diving objects using the entry form available on the DIVER website [4].
  - **Build your diving objects**, where you might want to make extra copies to keep because the objects sent to NASA won't be returned - unless at the ASGSR conference.
  - **Ship diving objects** - With appropriate care, pack and ship your diving objects to the following address.

    DIVER c/o Nancy R. Hall
    NASA Glenn Research Center
    21000 Brookpark Road, MS 77-7
    Cleveland, OH 44135

- **When?**
  - **Proposals** must be submitted via e-mail by no later than Wednesday, February 1, 2017 . Team selections will be announced by Friday, February 10. At that time, a status e-mail will be sent to all teams who submitted proposals.
  - **Team-built diving objects** should be sent to NASA when ready but must arrive at NASA no later than Wednesday, March 15 (or they risk rejection). Drop tower testing of the teams' objects should be completed by the end of that month. Video results will be provided to the teams after their objects have been tested in the drop tower.
  - **Video results and the student analyses** will form the basis for a poster presentation at the ASGSR conference on Oct 28, 2017 (see below).
- **Analysis & reporting**
  - **Analyze results** - NASA will record and electronically provide teams with the video of their diving objects being tested in the 2.2 Second Drop Tower.
  - **Analysis tips** – There are several available software tools to analyze video, where a few are listed here. These are just suggestions and are not meant to indicate endorsements by NASA.
    - SPOTLIGHT, http://microgravity.grc.nasa.gov/spotlight/
    - TRACKER, https://www.cabrillo.edu/~dbrown/tracker/
    - IMAGEN, http://gromada.com/imagen/
    - 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.

- **Prepare poster, presentation, and/or report** to share the results with NASA researchers, parents, and others.

- **ASGSR conference**
  - **Present poster** – Participating teams are strongly encouraged to attend and present a poster about their research in a student session at the annual conference of the American Society for Gravitational and Space Research (ASGSR) in Seattle, Washington on Saturday, October 28, 2017 [5]. Admission will be free on that day for a limited number of students who present their posters at the conference. Accompanying teachers/advisors and chaperones will also receive free admission. Note that the free admission doesn't include meals or participation in the evening banquet. Some limited travel support will be made available to non-local teams who present their results at the conference. Awards will be presented to teams on that day based on the posters and success with the challenge.
  - **Other student activities** – The conference will also include opportunities for students to participate in a design challenge, tour the exhibit hall, attend research presentations, and interact with microgravity researchers and other students.

# Calendar

- ***Now*** open for proposals
- **Feb. 1, 2017** deadline for e-mail submission of proposals to NASA
- **Feb. 10** selected teams announced by NASA by this date
- **Mar. 15** deadline for objects to arrive at NASA
- **Mar. 15 - 31** testing student objects by NASA
- **Sat., Oct. 28** student day at the ASGSR conference

# Key Rules

- **Proposals:** 5 maximum per organization (e.g., school), with 1 maximum per team
- **Team:** teams can be of any size, but each student can only be on a single team
- **Buoyancy:** diving objects must float in water under normal-gravity conditions
- **Number:** up to 3 objects per team
- **Size:** an object's longest dimension may be no more than 65 mm and no less than 5 mm,
- **Prohibited materials:** fragile materials (e.g., glass), hazardous materials (e.g., that are corrosive, toxic, radioactive).

# Hints

- **Begin design soon:** Research and develop preliminary designs early. Perform normal-gravity testing of shapes and materials. Consider putting trial objects with water in a plastic jar and dropping the jar in front of a video camera to get a glimpse of what happens in microgravity.
- **Two+:** Include two or three different objects for testing so that you can compare their test results.
- **Timing is important:** The drop duration is only 2.2 seconds.

# Selected FAQs

**Q: How are** microgravity [6] **conditions created?**
**A:** Through free fall. 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.

**Q: What is a conceptual drawing?**
**A:** A conceptual drawing could be called a sketch. The drawing should show the approximate size and shape of each object and indicate the planned materials. They can be drawn by hand, with standard software (e.g., PowerPoint), or using Computer Aided Design (CAD). The submitted drawing must be in JPG or PDF format.

**Q: Does the number of objects proposed affect the odds of selection?**
**A:** Preference will be given to plans with two or more objects because their results can be compared.

**Q: Where do we get the entry form?**
**A:** From the DIVER challenge website.

**Q: Can we build a diving object using a 3-D printer?**
**A:** Yes.

**Q: Can we simply buy a diving object?**
**A:** Yes.

**Q: Do we get our diving object back?**
**A:** A team's objects will not be returned unless a team representative is at the ASGSR conference, so you may want to build extra copies to keep.

# References


1. **2.2 Second Drop Tower:** http://facilities.grc.nasa.gov/drop/
2. **NASA Glenn Research Center:** http://www.nasa.gov/centers/glenn/home/
3. **Sample video:** This **YouTube** video shows a middle-school student team's ping pong ball in water during microgravity in the 2.2 Second Drop Tower. https://www.youtube.com/watch?v=wOqYCt-n2ts
4. **DIVER web site:** https://spaceflightsystems.grc.nasa.gov/diver/
5. **ASGSR 2017 Meeting:** https://asgsr.org/index.php/meetings/2017-meeting
6. **Microgravity explained:** http://www.nasa.gov/centers/glenn/shuttlestation/station/microgex.html


# Questions?

Check the DIVER website or send an e-mail to celere@lists.nasa.gov.