“Up and Away”

This award explores the world of fluid dynamics, and how it affects your everyday life. Fluid dynamics is the study of how fluids (liquids, gases, and plasmas) behave and interact with other materials.

1. Choose A *or* B *or* C and complete ALL of the requirements.
   A. Watch not less than three hours total of shows or documentaries that discuss fluid dynamics, or a show related to fluid dynamics. You may choose to watch a live performance or demonstration where fluid dynamics is being highlighted instead of watching a media production. Then do the following:
      1. Make a list of at least five questions or ideas from the show(s) you watched.
      2. Discuss two of the questions with or ideas with your counselor.

   Some examples of shows to watch include—but are not limited to; documentaries produced by PBS (such as “NOVA”), the Discovery Channel, Science Channel, National Geographic Channel, and the History Channel; or lectures or presentations focused on science, technology, engineering, or math (such as TED Talks www.ted.com) using some search terms you might think such as “fluid dynamics for kids” or “the science of flight.” You may watch online productions with your counselor’s approval and under your parent’s or guardian’s supervision. You may choose to watch a live performance, demonstration or movie at a museum or other venue where fluid dynamics is being highlighted instead of watching a media production.

   B. Read not less than three hours total about a topic related to fluid dynamics. Then do the following:
      1. Make a list of at least two questions or ideas from the article(s) you read.
      2. Discuss two of the questions with or ideas with your counselor.

   Examples of magazines include—but are not limited to—Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Aviation Week, Science News, and Scientific American.

   C. Do a combination of reading and watching (not less than three hours total). Then do the following:
      1. Make a list of at least two questions or ideas from each article or show.
      2. Discuss two of the questions with or ideas with your counselor.

2. Complete ONE merit badge from the following list. (Choose one that you have not already used toward another Nova Award). After completion, discuss with your counselor how it relates to fluid dynamics.

Archery	Kayaking	Rifle Shooting	Shotgun Shooting
Aviation	Oceanography	Rowing	Space Exploration
Canoeing	Plumbing	Scuba Diving	Swimming
Chemistry			

3. Complete two activities from A *or* B *or* C *or* D. Complete all of the items under each activity.
   A. Investigate terminal velocity.
      1. With your counselor, fill an empty tennis ball tube, or other clear plastic tube at least 12" tall, with clear corn syrup or another liquid.
      2. Drop two round objects with the same diameter but different masses, that will sink, into the liquid (example: a steel ball and a glass marble).
      3. Define terminal velocity. Note when the two balls reach terminal velocity (it should happen quickly). Did both objects have the same terminal velocity? Try the experiment again to see if it's repeatable.
      4. Discuss your investigation and findings with your counselor.
   B. Test Fluid Dynamics in liquids and gases,
      1. The study of fluid dynamics can include both liquids and gases. On Earth, two of the most common are air and water. With your parents' permission or working with your counselor, look at how a golf ball or other sphere would travel through the air and through water. What would be the standard equations for a sphere to travel through air? Through water? What is the key difference between the two? Remember both are fluids.
      2. After looking at the math behind the motion of a sphere through a fluid perform an experiment to support what you have learned.
      3. Drop a sphere from a height of between one and two feet in both air and in water. Your height will likely be dependent on what you have to hold water since you want the height to be the same for dropping your sphere or ball in water and in air.
      4. Perform your test several times in each fluid.
      5. About how long did it take for your object to hit the ground in air? In water? What did you notice as you dropped the object in each fluid?
      6. Show and discuss with your counselor your findings regarding the difference in the equations used for the motion of the sphere and the results of your experiment.
   C. Develop a parachute delivery system.
      1. Use lightweight recycled materials or snap-together building blocks to construct a crate or harness to contain your payload, an egg or other object approved by your mentor. Using an egg would test the survivability of the system given the nature of an egg. To reduce mess and complexity you may want to use a hard boiled egg which will show damage but not be as fragile.
      2. Use common household materials, such as trash bags, plastic tablecloth, string, paperclips, rubber bands, etc. to design a parachute that will safely deliver your payload safety to the ground from an appropriate height. The Guide for Safe Scouting should be followed regarding 'dropping' of your payload.
      3. Design your parachute first on paper, then create a prototype and test it. You may want to first use a 'dummy' payload to simulate your package since the package is easy damaged. It is advisable to test your system outdoors due to possible failure in your designs.
      4. Record how long it took to land and the condition of the payload.
      5. What could you do to slow the descent even further? Modify your design and test it out again. Record the results then modify and test again.
      6. Conduct a final test (at least three tests total) and record your best (slowest) time.

7. Show your system, parachute and harness, to your counselor and explain how you designed and modified it. Talk about how the system worked and how both the parachute and the harness contributed to a successful delivery of your package. What were some of the key factors that contributed to the success or failure of your design. Could what you designed be scaled up for large payloads both in size and weight?

D. Test out different airfoils.
   1. Construct simple airfoil shapes using sheets of plain paper secured with tape.
   2. Make a "testing apparatus" that allows the airfoil to move freely in the vertical direction using drinking straws and skewers.
   3. Using a fan or hair dryer, direct a flow of fast-moving air across the airfoil and observe how high it lifts off from the testing apparatus. Use a ruler marked with centimeters to measure results. Repeat changing the test parameters, e.g., how fast the air flows, the direction of the air flow, etc.
   4. Research the Bernoulli Effect and discuss how this phenomenon applies to your observations of the airfoils.
   5. Discuss the results with your counselor.

4. Complete one of the following A or B or C.
   A. Visit a research facility, other facility where fluid dynamics is studied or takes place such as iFLY. This could include but is not limited to facilities such as a waste treatment plant, bottling plant, airport, or a government or private research center. During your visit, talk to a staff member about flight or fluid dynamics concepts covered at the site. Discuss what you learned with your counselor.
   B. Visit a museum that highlights flight, aviation, or space. During your visit, talk to a docent or staff member about flight and fluid dynamics concepts covered at the site. Discuss what you learned with your counselor.
   C. Take a real or online tour of a wind tunnel facility. A real tour may be obtained by contacting a local university that offers a degree in aerospace engineering or similar field. Virtual tours could include, but are not limited to, NASA wind tunnel facility tours: https://www.youtube.com/watch?v=bpRc9l8LMXo and https://www.nasa.gov/image-feature/hypersonic-tunnel-facility/ Discuss with your counselor the science and engineering concepts associated with the facility, e.g., what are the parts of a wind tunnel, what a wind tunnel is used for, what are the advantages of testing with a wind tunnel, how precise are they, etc.

5. Discuss with your counselor how fluid dynamics is present in your everyday life and what you learned by working on this Nova.

Revised May 21, 2022
Revised 6/1/2025