LINDBERGH ELECTRIC AIRPLANE FLIGHT (LEAF) CHALLENGE
Trial Event Rules 2019
Washington State Science Olympiad

1. **DESCRIPTION:** Prior to the tournament, teams design, build, and test a tethered electric aircraft that carries as heavy a load as possible.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** C

   IMPOUND: Yes **APPROXIMATE TIME:** 15 Minutes

2. **EVENT PARAMETERS:**
   a. Teams must bring one electric aircraft, the team's visual display, items being used as cargo (pennies, wheel weights, etc.) and any tools necessary to repair or modify the airplane.
   b. Supervisors will provide the power pole (Kelvin part # 851508 or equivalent), variable power supply (Kelvin part # 841051), 250 cm long wire leads with alligator clips and a hook, and other necessary items (such as safety cones, stanchions, extension cords, etc.) to set up a flight circle.
   c. Students must wear eye protection at all times when in the cordoned-off area. Teams without proper eye protection will be given an opportunity to obtain proper eye protection, but not additional time.

3. **CONSTRUCTION PARAMETERS:**
   a. Airplanes may measure no more than 91 cm in any direction.
   b. No commercial kits or lighter-than-air materials may be used in the construction of the airplanes. NOTE: Lighter-than-air includes no helium-filled bladders attached to planes to generate additional lift.
   c. Teams must use an electric motor (Kelvin #850647, #851950 or TeacherGeek #1821-70) and are limited to one motor per airplane. The motor must be installed in the airplane so as to be visible to the judges on the day of the competition.
   d. Teams may use any materials to construct the aircraft including but not limited to wood, paper, foam, etc. Students are responsible for constructing the wings and fuselage. No commercial kits are acceptable.
   e. Teams may use any type of take-off and landing gear that does not mark or alter the floor of the flight circle.
   f. Teams may use any type of non-metallic propeller and/or hub.
   g. Cargo may be any solid material. It may be any shape or form that does not provide additional lift. It must be attached in a manner that does not provide additional lift. Cargo must be easy to remove to allow for expedited measuring.
   h. Electricity to the motor will be supplied by a variable power source and power pole (see 2.b). Leads shall run from the motor to the tip of one of the plane's wings to allow alligator clips to be attached quickly and easily.
   i. Each team must clearly label their airplane and visual display with their organization, team name and team number.
   j. Airplanes that do not meet the construction parameters will be scored below teams with airplanes with no construction violations. At the sole discretion of the event supervisor, airplanes deemed to be unsafe for flight may be prohibited from flying.

4. **TESTING APPARATUS:**
   a. The flight circle will be constructed with a power pole at the center of the circle with 2.5m leads, creating a 5m flight circle diameter. Alligator clips will attach to the ends of the leads to allow teams to easily attach and detach each team's airplane. Teams are also encouraged to use the extended hook adjacent to the alligator clips to relieve tension as well as provide a safety precaution.
   b. Safety cones or stanchions shall be placed around the perimeter of the flight circle. One of these shall be the height verification apparatus (see 5.b.i). The area will be cordoned-off.

5. **THE COMPETITION:**
   a. Students will have a total of 8 minutes in the flight circle.
   b. Students demonstrate proof of concept by flying two or more consecutive laps at a height greater than or equal to 20 cm.
      i. The lap shall be considered successful if the bottom of the landing gear passes above the 20 cm mark as indicated by the height verification apparatus, a clearly-marked stanchion or meter stick located at the edge of the flight circle.
      ii. After a successful lap, students weigh the empty airplane (measured to the precision of the available scale) then add cargo and attempt to fly with cargo.
   c. After successfully flying the airplane with cargo, the aircraft shall be weighed again. The difference between the final weight and the initial weight shall be differential weight (Δweight).
   d. Students may make as many attempts as time allows to increase the amount of cargo carried by the team's plane. Each time a team successfully flies with cargo, the team may choose to have an official weight taken. When an airplane is being weighed, the clock will pause. Only official weights will be counted when determining the amount of cargo carried.
   e. At a separate station, students will respond to interview questions regarding their design process and device, supplementing their responses with their visual display. (See 6.a.i and 6.a.ii)
   f. Students may not receive outside assistance during the flight or interview portion of the competition.
6. **SCORING:**
   a. Highest overall score wins.
   b. Overall score is calculated by adding Visual Display Score (V), Interview Score (I), and the Airplane Performance Score (AP).

$$\text{Overall Score} = \text{V} + \text{I} + \text{AP}$$

   c. Subscores will be determined as follows:
      i. Visual Display (V) (25 points)
         (1) Teams will submit their visual displays at impound on a 51 cm x 76 cm (20" x 30") foam board with the following headings: Organization and Team Number & Development, Scientific Principles, Testing Data, Problems Encountered, Conclusion, Material Resources and Working Drawings.
         (2) The supervisor or designee will evaluate the visual displays for completeness and quality.
         (3) Visual Displays submitted after impound may be evaluated at supervisor's discretion and with a competition violation.
      ii. Interview Score (I) (25 points)
         (1) Each team will answer questions from one or more supervisors about their engineering process and aerodynamics principles that apply to the team's airplane.
         (2) Event Supervisors will ask the same 3 questions to each team.
         (3) Event Supervisors will also ask 2 additional questions unique to each team's design or process.
         (4) Responses will be scored for alignment with engineering practices and the thoroughness of the participants' understanding of principles of aerodynamics.
      iii. Airplane Performance Score (AP) (50 points)

$$\text{Airplane Performance Score} = 15(\text{flight w/o cargo}) + 35(\Delta\text{weight}_{\text{team}}/\Delta\text{weight}_{\text{max}})$$

   d. Teams in tier 1 will be scored above teams in tier 2 who will be scored above teams in tier 3.
      i. Tier 1: Airplanes that meet all construction parameters and teams have no competition violations.
      ii. Tier 2: Airplanes with construction violations
      iii. Tier 3: Teams with competition violations

e. Ties between teams will be broken by the highest-scoring Airplane Performance (AP) followed by the Interview (I).

Recommended Resources: Training resources are available on the project web site: http://www.LEAFchallenge.com

NATIONAL SCIENCE EDUCATION STANDARDS:

Middle School- NGSS

Forces and Interactions
MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Energy
MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Engineering Design
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

High School- NGSS

Forces and Interactions
HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

Energy
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Engineering Design
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts