MESA DAY RULES 2019-2020

(FINAL)

Wright Stuff Glider

LEVEL: Middle School

DIVISION(S): Grade 6th and Grades 7th/8th

COMPOSITION OF TEAM: 2-3 students per team

NUMBER OF TEAMS: Preliminary – Determined by your local Center
Regional – one team per division per Center

SPONSOR: UC Santa Cruz MESA College Prep

OVERVIEW: Students will design and construct a glider that, when launched by the official MESA launcher, flies through the air and lands on a target located in front of the launcher. The target will be identified by a colored dot on two pieces of blue painter's tape that intersect to form a + symbol on the ground and is located 12.2 meters (40 feet) away from the launcher's hook (once released). The glider must be the original work of each team. Judges may ask questions for verification. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their center director.**

An Engineering Lab Book is a required component of this competition. The purpose of the Engineering Lab Book is for students to more closely follow the practices of an engineer in the completion of their MESA Day projects. The Engineering Lab Book will encourage students to take a purposeful and sustained approached to building their devices. MESA projects are not designed to be completed in a single class period or day, but to be the result of thoughtful research, planning, analysis and evaluation. The lab book should provide a daily and constant written record of the thought and insight that a team is putting into their project, from initial ideas to the final completed project.

MATERIALS: LEGAL:
Various materials may be used to build the glider; materials are not limited to wood. Students should consider the strength of the material needed to withstand the force of the launcher. There is no restriction to the size and/or weight of the glider.

ILLEGAL:

- Hazardous materials (to be determined by the host center)
- Remote control devices of any kind
- Additional power source(s) (i.e., thrust, lift or stored energy that assists dynamic flight) may NOT be supplied.

Three format options are available for lab book submittals. **See *"MESA DAY 19_20 General Lab Book Guidelines"*** at http://mesa.ucop.edu/. Please check with your local center director for the format required for your preliminary event. Electronic submissions will be required at the Regional/State level.

The Host Center will provide the following:

- 1 six-foot table for the launcher
- 2 six-foot tables for the impound station
- 1 six-foot table for the repair station
- Two official launchers as described in these rules; one launcher will serve as back-up. Each launcher will have a new spring and new launch hook.
- Safety goggles for team members and judges

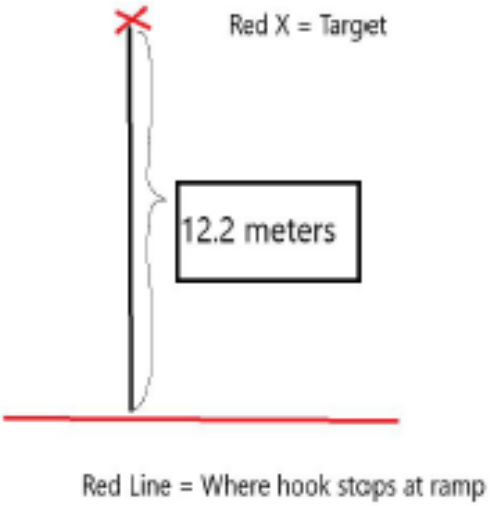
GENERAL RULES:

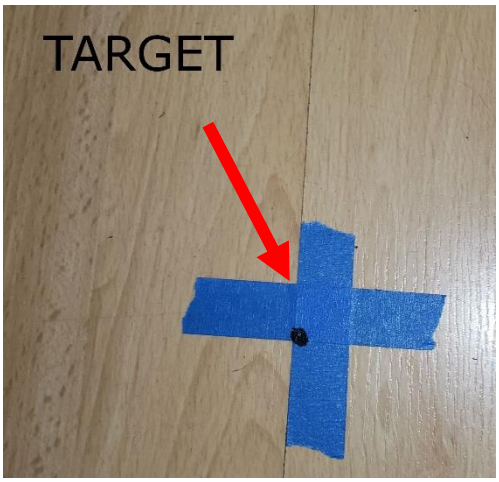
1) The students' full name, grade level, school name, and MESA Center MUST be clearly labeled on the glider. Failure to properly label the glider will result in a 10% penalty applied to the final score. Gliders checked-in with a tie-on label will be required to launch having the labeled tied on.
2) The glider MUST contain an easily identifiable, prominent feature on the fuselage that adapts and connects with the launcher's hook. **The adaptation MUST be identified by a red dot.** Failure to label the glider's adaptation **with a red dot** will result in a **10% penalty being added to the final score.**
3) Teams may only register/turn-in one glider for the competition.
4) All repair materials and tools MUST be provided and turned in by each team when registering at check-in. A toolkit provided by a school representative is permitted.
5) For the purpose of this competition, a glider is defined as a self-contained flying vehicle that remains intact during flight. The glider cannot have links of any kind with the ground that provide lift, propulsion or course guidance during the flight.
6) Glider parts that break off during LANDING (i.e., upon initial impact with the ground or any object) are permissible but are not encouraged.
7) **If parts of the glider break off DURING flight (i.e., while in flight), the launch is considered a MISTRIAL. Flights that result in a mistrial are NOT eligible for points.**
8) Any glider that alters or damages the launch hook will be DISQUALIFIED.
9) The glider must have features to avoid being caught in the slot in the launch ramp. Wheels and skids MUST be positioned to avoid the slot.
10) Gliders can be made from various materials and have no restrictions on size or weight. The glider MUST be capable of being launched by the official launcher's hook and MUST have an identifiable fuselage, wing, and tail. Gliders without the required components will be DISQUALIFIED.
11) Remote-control (electronic) devices of any kind ***may not*** be used. If mechanical devices are used, these devices must be self-contained and may not provide any thrust to the glider.
12) Additional power source(s) (thrust, lift or stored energy that assists dynamic flight) may NOT be supplied. The only power source allowed is the official glider launcher.
13) The judges' decision regarding the location of the glider's first-touch point (i.e., landing location) is considered final and is not subject for debate. Digital media (e.g., photos and/or video recordings) will not be accepted for arbitration purposes.
14) Only team members can hold and repair their glider. The impound and repair station areas will be supervised by competition judges. Advisors, guardians, parents, and/or teachers are not allowed in the designated impound/ repair areas.

15) Lab books are meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.

JUDGING:

1) Gliders will be checked for specifications prior to the start of the competition. Disqualified teams after this initial check will have an opportunity to compete if they meet ALL of the following conditions:
   a. Accept an automatic "Mistrial" and therefore no score for Launch #1.
   b. Make repairs/modifications as necessary to meet the specifications and are ready to compete when called for Launch #2.
   c. Make repairs/modifications only in the designated area as indicated by the judges.
   d. Failure to adhere to any of a, b, or c will result in the disqualification being upheld.
2) Teams that are not disqualified but wish to make repairs and modifications may do so, but they MUST be ready to compete when called for Launch #1.
3) The target will be identified by a colored dot on two pieces of blue painter's tape that intersect to form a + mark on the ground and is located 12.2 meters (40 feet) away from the launcher's hook (once released).





4) The vertical distance between the ground and the bottom of gliding block is 100cm (39.4 inches). The height of the ramp at the point where the hook stops moving is 100 cm (39.4 inches) above the ground.

5) Each team MUST be ready and report to a judge within 30-seconds of being called to launch their glider. Failure to report within 30-seconds of being called will result in a forfeited trial/launch.
6) Each team will have two non-consecutive opportunities for their glider to be launched. Teams will be given a 2-minute window to set-up their glider.
7) Judges will give teams a 5-second countdown prior to the judges pulling the release pin/releasing the trigger in order to initiate flight.
8) The glider's first-touch point (contact with any object) will be marked by the judges.
9) The distance between the target's center and the glider's first-touch point will be measured to the nearest 2 cm (0.75 inches).
10) The decision of the judges on the location of the first-touch point is final and not up for debate.
11) Teams are responsible for removing their glider from the contest area immediately after judges have marked the first-touch point.
12) One member of each team will be asked to place their glider on the impound table (an area designated by the judges) or the repair station table after every trial.
13) All glider repairs and/or alterations MUST be made under the supervision of a judge. New/spare/ replacement parts ARE NOT ALLOWED. Repairs or alterations can ONLY be made with parts originally used when the glider was submitted for specification checks. Glue and/or tape to affix broken pieces is ALLOWED.
14) Both trials will be timed (to be used as the tiebreaker only). Times will be recorded, at a minimum, to the nearest hundredth second. The timing of the flight ends when any part of the glider comes in contact with any object (first-touch point). In case of a tie, the longest flight duration (hang-time) will be used as a tiebreaker.

SCORING:

1) Launch #1 = Distance from the target after first launch
2) Launch #2 = Distance from the target after second launch
3) A deduction of 20% of the team score will be assessed for an incomplete lab book and a deduction of 50% of the final score will be assessed for a missing lab book.
4) Final Score = Best launch plus (+) possible penalties
   a Since the penalties from the lab book and proper labeling will be added to the final score, the following will serve as an example of how judges will factor in penalties on MESA Day.

   Team # 1 has a best launch of 20cm from the target and did not receive a penalty (they turned in their engineering lab book and all competition related materials are properly labeled).

   - Best Launch = 20cm from target
   - Penalties = None
   - Final Score = 20cm

   Team # 2 has a best launch of 20cm from the target and they did not turn in their engineering lab book and their glider is not properly labeled.

   - Best Launch = 20cm from target
   - Penalties Total = 50% for missing lab book (+10cm), 10% for improper labeling (+2cm) = 12cm
   - Final Score = 20cm from target + 12cm penalties = 32cm from Target
5) Tie Breaker: if there is a tie among Final Scores, the glider with the longest single flight time will be the winner.

AWARDS:

- Awards will be given per division: Grade 6th and Grades 7th/8th.
- Equal medals will be awarded in case of a tie.
- Only 1st Place teams in each division will advance to Regional/State MESA Day.

ATTACHMENTS/APPENDIX:

- A – Engineering Lab Book Mathematical Concepts
- B – Official Launcher Specifications
- C – Launch Hook & Spring Specifications
- D – Wright Stuff Glider Inspection and Score Sheet

A - ENGINEERING LAB BOOK MATHEMATICAL CONCEPTS

Use of mathematical concepts/equations: MESA has provided a set of equations to help you along the way. While these equations are not mandatory to use, they should provide a roadmap to completing the math concepts.

1. Final Velocity = $\frac{\text{2 x displacement of glider}}{Time} - Initial\ Velocity$
2. *Force (F) = mass (m) x acceleration (a)* → $F = ma$

Applicable Math Concept/equation (state concept/equation): Calculating Final Velocity

Both final and initial velocity are measured in meters per second (m/s), time is measured in seconds (s), and displacement is measured in meters (m). To find the final velocity, we can rewrite the equation for displacement.

How to rewrite the Displacement Formula.

Step 1: $Displacement\ of\ Glider = \left(\frac{Final\ Velocity + Initial\ Velocity}{2}\right) x\ Time$

Step 2: 2 x Displacement of Glider = (Final velocity + Initial Velocity) x Time

Step 3: $\left(\frac{2\ x\ Displacement\ of\ Glider}{Time}\right) = Final\ Velocity + Initial\ Velocity$

Step 4: $\left(\frac{2\ x\ Displacement\ of\ Glider}{Time}\right) - Initial\ Velocity = Final\ Velocity$

Rewritten Formula: Final Velocity = $\left(\frac{2\ x\ Displacement\ of\ Glider}{Time}\right) - Initial\ Velocity$

Since your glider is starting at rest, the initial velocity will be 0 m/s, the time will be the time of your flights duration, and the displacement will be how far your glider traveled.

Example: If your glider traveled 7 meters in 5 seconds. What was the final velocity of your glider?

Rewritten Formula: Final Velocity = $\left(\frac{2\ x\ Displacement\ of\ Glider}{Time}\right) - Initial\ Velocity$

Step 1: Plug in known Variables: Final Velocity = $\left(\frac{2\ x\ 7\ meters}{5\ seconds}\right) - 0\ \left(\frac{meters}{second}\right)$

Step 2: Solve for Final Velocity: Final Velocity = $\left(\frac{14 meters}{5\ seconds}\right) \rightarrow Final\ Velocity = 2.8\ \left(\frac{meters}{second}\right)$

Applicable Math Concept/equation (state concept/equation): Calculating Force

Force is measured in Newtons (N), mass is measured in kilograms (kg), and acceleration is measured in meters per second squared (m/s^2). The mass of the glider is calculated by weighing it. The formula for force is denoted above and the formula for acceleration is:

$$Acceleration = \left(\frac{Final\ Velocity - Initial\ Velocity}{Time}\right)$$

Since the glider will be at rest, the initial velocity will be 0 meters/second. The time will be the amount of time that it takes your glider to hit the ground (first touch point). You can use the formula denoted above to calculate final velocity. Using the final velocity form the previous example, we know that the final velocity is 2.8 meters per second (m/s). We also know that the time it took to achieve this velocity is 5 seconds. Given that the initial velocity is zero, we can now calculate acceleration (a).

$$a = \left(\frac{Final\ Velocity - Initial\ Velocity}{Time}\right)$$

$$a = \left(\frac{2.8\ \left(\frac{m}{s}\right) - 0\ \left(\frac{m}{s}\right)}{5\ seconds}\right) \rightarrow a = \left(\frac{2.8\ \left(\frac{m}{s}\right)}{5\ seconds}\right) \rightarrow a = 0.56\ (m/s\text{^}2)$$

Now we can calculate the force being used to calculate the glider.

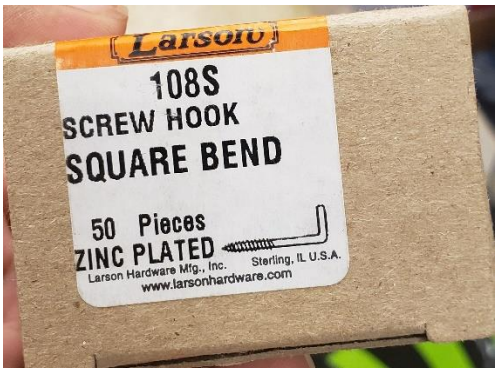
Example: If your glider weights 0.453592kg (1 pound) and has an acceleration of 0.56(m/s^2), calculate the force being used to move the glider.

Force = mass (kg) x acceleration (m/s^2).

Force = 0.453592kg x 0.56 (m/s^2) = 0.25N → Force = 0.25N.

B – OFFICIAL LAUNCHER SPECIFICATIONS

1) The only power source allowed for the glider to use is the official glider launcher.
2) The official launcher consists of a tension spring, a launch platform and a launch hook.
3) The tension spring is an 11" spring with a 0.17 pound per inch spring rate. It is available from McMaster-Carr, currently listed on https://www.mcmaster.com/9640k243 as part number 9640K243. It will be stretched 30.0 inches from its final position. The estimated tension load in the spring at the start of launch is 5.87 pounds. After launch the final length of the spring is 1.25". In the final position, the spring has a load of 0.77 pounds. In the completely relaxed state, the spring has a preload of 0.73 pounds. The spring has an outer diameter of 1.00" and a wire diameter of 0.062 inches. The mass of the spring is 170 grams.
4) The launch platform has an overall surface size of 30.5 cm (12 inches) in width and 147 cm (58 inches) in length. The surface is hard and smooth and made from ¼" thick composite board or comparable material. A slot runs down the middle of the platform that is 5/35 mm (0.2 inches) wide and is 8cm (31.5 inches) long. The end of the slot is located 30.5 cm (12 inches) from the end of the launch ramp. The launch ramp is angled at 5 degrees above horizontal. The height of the ramp at the point where the hook stops moving is 100 cm (39.4 inches) above the ground.
5) The launch hook is made from steel wire with a 4.064 mm (0.160 inch) diameter. It is available from McMaster-Carr, currently listed on https://www.mcmaster.com/catalog/125/3060 as part number 9594T13.



6) The hook is screwed into a glide block mounted underneath the launch ramp. The mass of the hook and glide block is 35 ± 2 grams.
7) Each host center will replace their launcher's tension spring and launch hook for all MESA Day events and will provide a new spring and new launch hook before the start of the glider competition(s).
8) All glider launchers will include a safety feature that will be set in place before the launcher's spring (trigger) can be released.

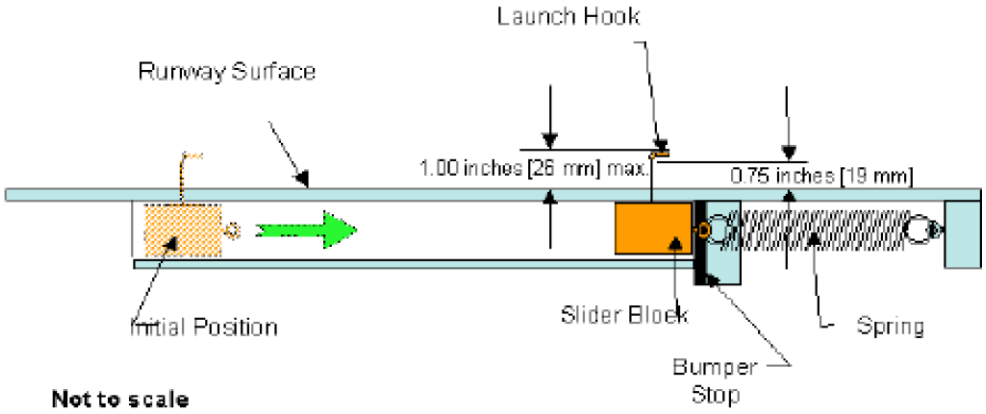


Figure 1: Launch Device – Side View

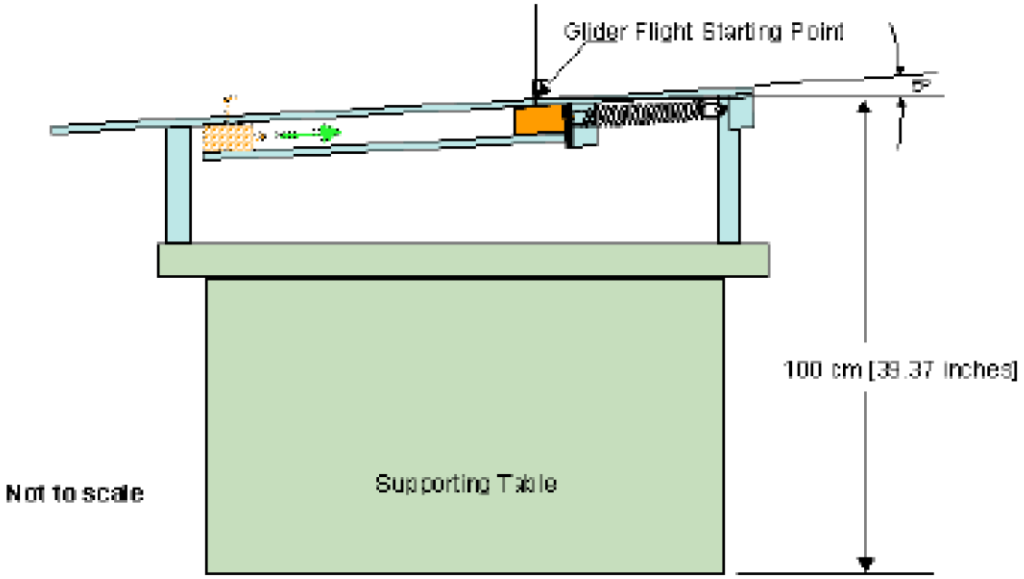


Figure 2: Launch Device Set-up – Side View

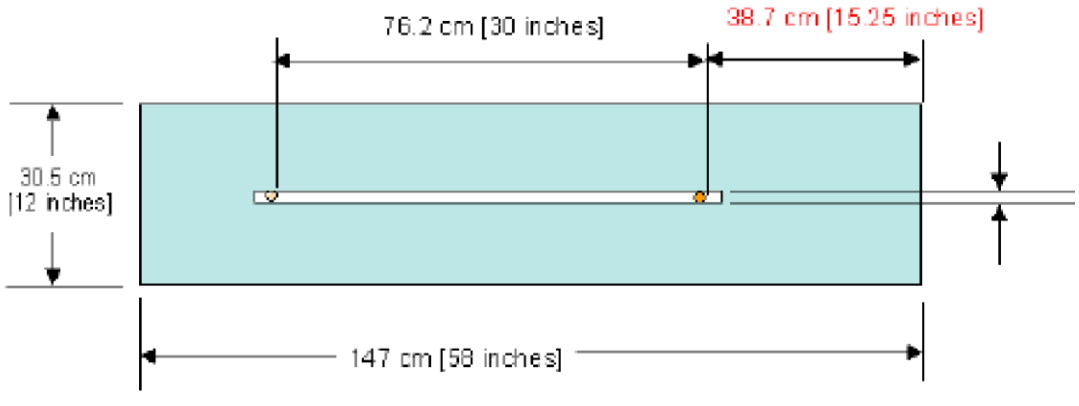


Figure 3: Launch Device – Top View

C – LAUNCH HOOK & SPRING SPECIFICATIONS

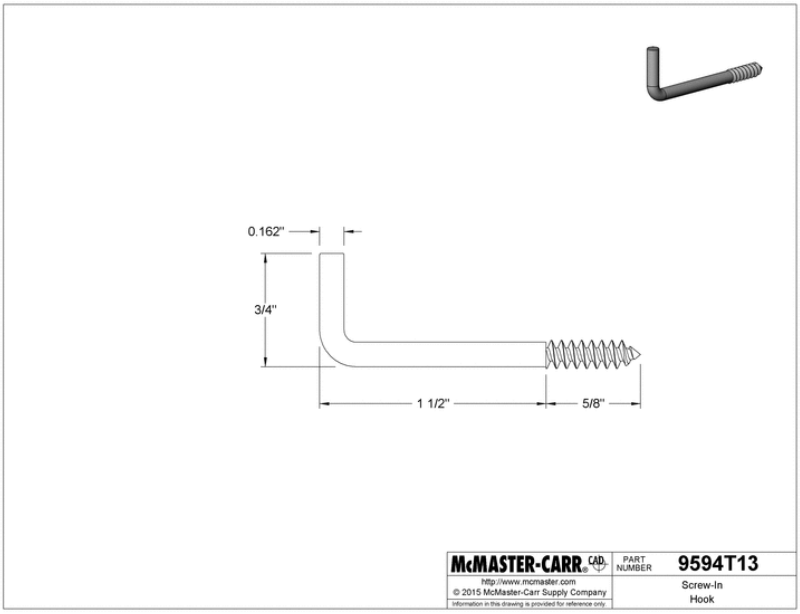
https://www.mcmaster.com/9594t13

McMASTER-CARR

Find

Screw-In Hooks

0.160" Diameter, 1-1/2" Projection, 3/4" Overall Height

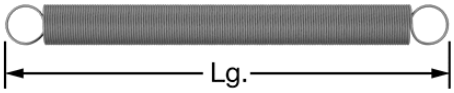


McMASTER-CARR

9640K243

Extension Spring

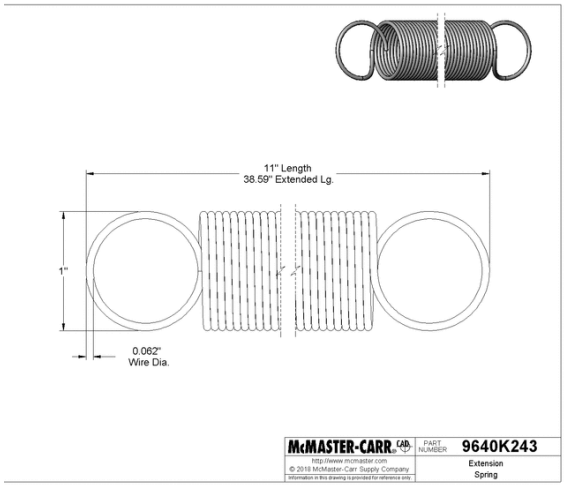
with Loop Ends, 11" Long, 1" OD, 0.062" Wire Diameter



Packs of 1

In stock
$5.59 per pack of 1
9640K243

ADD TO ORDER



Spring Type	Extension
Length	11"
OD	1"
Wire Diameter	0.062"
Extended Length @ Maximum Load	38.59"
Load, lbs.	
Min.	0.73
Maximum	5.42
Rate	0.17 lbs./in.
Material	Spring-Tempered Steel
End Type	Loop
OD Tolerance	Not Rated
Min. Load Tolerance	Not Rated
Rate Tolerance	Not Rated
RoHS	RoHS 3 (2015/863/EU) compliant

As you stretch an extension spring, it gets harder to pull. Minimum load is the amount of force required to start to extend the spring. Maximum load is the amount of force required to fully extend the spring. Rate is the amount of force required for every inch of extension.

D – WRIGHT STUFF GLIDER INSPECTION AND SCORE SHEET

Student 1 Name: _____ Grade: _____

Student 2 Name: _____ Grade: _____

Student 3 Name: _____ Grade: _____

School Name: _____ Center: _____

Specification Checklist:	**Yes**	**No**
Are the contestants' names, grade, school name, and center clearly visible on the glider? *(if information is provided on a tie-on label—student MUST launch glider with label attached.)* - General Rule #1		10% penalty
Does the glider contain a feature that adapts to the launch hook that is easily identifiable by a red dot? - General Rule #2		10% penalty
Is glider capable of self-sustained flight without links to the ground for lift, propulsion or guidance? - General Rule #5		DQ
Does the glider contain a feature that prevents it from getting caught in the "slot" of the launch ramp? - General Rule #9		Can result in DQ
Glider has easily identifiable fuselage, wing, and tail? - General Rule #10		DQ
Does glider use remote controls? - General Rule #11	DQ	
Will stored energy be used after the initial launch? (thrust, motors, batteries, etc.) General Rule #12	DQ	
Overall Specification Check	**Pass**	**Fail**

Engineering Lab Book	**Yes**	**No**
Is this considered an incomplete lab book? *(See "19_20 General Lab Book Guidelines")*	20% Penalty	
Is this considered a missing lab book? *(See "19_20 General Lab Book Guidelines")*	50% Penalty + Cannot place	

Performance Test:

Measure to the nearest 2cm (0.75inches)

Distance to Target's Center & Glider's 1st Touch-point w/ ground or other obstruction:	**If the launch is disqualified or considered a mistrial, please indicate it below:**
1st Launch:	DISQUALIFICATION MISTRIAL
2nd Launch:	DISQUALIFICATION MISTRIAL

Reasons for Glider Disqualification(s):	**Reasons for Launch Mistrial:**
Glider altered or damaged the launch ramp "hook"	Glider part(s) brake-off during flight
The glider must be capable of being launched on the launch ramp by the hook and must have an identifiable fuselage, wing, and tail.	

Hang Time (needed for tiebreaker)
1st Launch Hang Time:
2nd Launch Hang Time:

Best Launch Distance _____

Penalty 1 + _____

Penalty 2 + _____

FINAL SCORE = _____