MESA DAY CONTEST RULE

2019-2020

Civil Structures

LEVEL:	Grades 9/10 and 11/12
TYPE OF CONTEST:	Team
COMPOSITION OF TEAM: NUMBER OF STUDENTS:	2-3 students per team Preliminary – As determined by your local MESA Center Regional - 1 for 9/10 Grade; 1 for 11/12 Grade per Center
SPONSOR:	Luis Topete, Director, San Diego State University MSP Jeanette Espino, Director, Imperial Valley MSP

OVERVIEW:

Students will design and construct a model balsawood bridge from their own plans that will carry a maximum load while using as little wood as possible, stressing neatness, craftsmanship, and creativity. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their center director.**

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:

- ¼" x ¼" square balsawood (ten 3 ft lengths usually sufficient)
- Only water-soluble Elmer's-type white glue.
- There are three format options for lab book submittals (See Engineering Lab Book Rules). 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.

GENERAL RULES:

1) Civil Structure should be labeled with team members' names, school, and MESA Center. There will be a 10% penalty in the strength to weight score for failing to properly label.
2) No Kits are allowed.
3) **Joints must be at or within ¼" of the end of at least one of the sticks (members).** No part of a stick may be glued to another stick except at the joints of sticks. i.e gluing is very limited. See Appendix C, "Clarification of Gluing."
4) No glue may extend beyond 3 mm of any joint.
5) The bridge MUST meet the following dimension restrictions:
   - **a.** Maximum length = **40 cm**
   - **b.** Maximum width = **10 cm**
   - **c.** Maximum height = **21 cm**
   - **d.** Minimum clearance = **10 cm**
   - **e.** Minimum span = **25 cm**
   - **f.** Maximum Bridge Weight = **95 grams**
6) Members joined at an angle must be at an angle of 30 degrees or more.
7) Members may be carved, notched, or cut anywhere along their length.
8) Pins and/or gussets are not allowed.
9) No material (e.g. paint, varnish, hairspray, etc.) may be applied to the bridge. Ink or pencil to identify bridge builders, school, and center is ok.
10) **Maximum allowable weight of completed structure is 95 grams.**
11) Top of bridge must support a 10 cm x 10 cm plate which will bear the load for testing.
12) Bridge must have supports at least 25 cm apart and must measure at least 10 cm above a flat surface (an imaginary "river") at at least one point (may be more than one point) between the supports.
13) Project must be the original work of student(s). Judges may ask questions to confirm provenance.
14) Please remember that the purpose of this contest is to use creativity to build the best structure within the framework of the rules. The purpose is not to break the rules and see if you can get away with it.
15) Lab books are meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.

    * The Engineering Lab Book must be properly labeled (names, school, center, grade level, etc.) and contain and cover the following sections using the template provided:

    1. ***IDENTIFY THE PROBLEM** (at least 2 sentences for each question below)
       State what is the challenge being worked on? What are the limits/constraints? How do you think you can solve it?
    2. ***EXPLORE**
       Find out what others have done (research). Clearly list at least 5 sources (web pages, books, etc.). Identify (cite) and describe them.
    3. ***DESIGN**
       Brainstorm ideas (at least 3 ideas) and record them. Each idea should be represented by a sketch or drawing. Select one idea and create a plan (at least 5 sentences) to build a prototype from. Generate a list of materials for your prototype.

4. ***CREATE**
    i. Using your plan, build your prototype; describe the building of prototype (at least 5 sentences). Include a picture of the actual project prototype.
5. ***TRY IT OUT**
    Test your idea/prototype. Attempt at least 3 trials/attempts of your test. Measure the results of your test (e.g., accuracy, time, kinetic energy, potential energy). Provide evidence of the use and application of at least 2 appropriate mathematical concepts in your tests, for example:
    i. Calculate the height, length, and width proportional to your bridge if it is to be built to fit two 8ft wide standard size sedan vehicles.
    ii. If balsawood has a cost of $16.5 per foot, calculate the amount it would cost to build your bridge that is proportional to fit two 8ft wide standard size sedan vehicles.
6. ***MAKE IT BETTER**
    Describe how you can make the project better and what modifications you will be making (at least 5 ways you can improve project). Build and prepare competition ready project. Include a picture.

JUDGING:

1) Prior to load testing, the bridge receives a specifications check to determine whether it conforms to the weight, dimension, and construction rules.
2) Bridge is weighed and its weight recorded.
3) Bridges are judged for neatness, craftsmanship, and creativity by a team selected by Host Center prior to testing.
4) Bridge will be tested for load bearing capacity using the set-up shown in Testing Setup & Apparatus. The maximum load recorded by the load testing machine will be used as the load capacity of the bridge, regardless of when failure begins.
5) Disqualified bridges are not eligible for awards in any category. However, they may be tested in private, time permitting.
6) Strength-to-Weight Ratio: Determined by dividing maximum load at failure by weight of bridge. Bridge with greatest load bearing capacity compared to its weight wins.

    Example: Maximum load = 120.0 pounds
    Bridge weight = 20.0 grams
    Ratio = 2724.0 * [120 pounds x 454g/pound) / 20g]

7) Creativity & Engineering Design: Finest workmanship, including neatness and innovation of design.

AWARDS:

- Awards will be given per grade level: 9th/10th grade and 11th/12th grade.
- Medals will be awarded for 1st, 2nd, and 3rd place based on the best Strength-to-Weight Ratio
- Ribbons will be awarded for Creativity and Engineering Design.
- Only teams placing 1st place in the Strength-to-Weight category (from each grade level) will advance to Regional MESA Day.

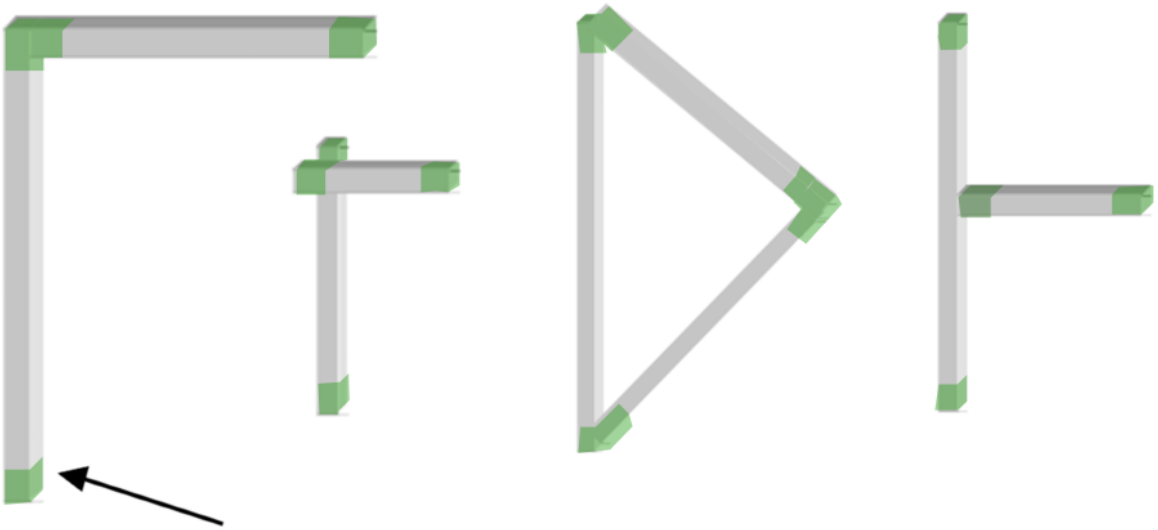
ATTACHMENTS/APPENDIX:

- A - Sample Joints
- B - Testing Setup & Apparatus
- C - Clarification of Gluing
- D - Specification Checklist

A – Sample Joints

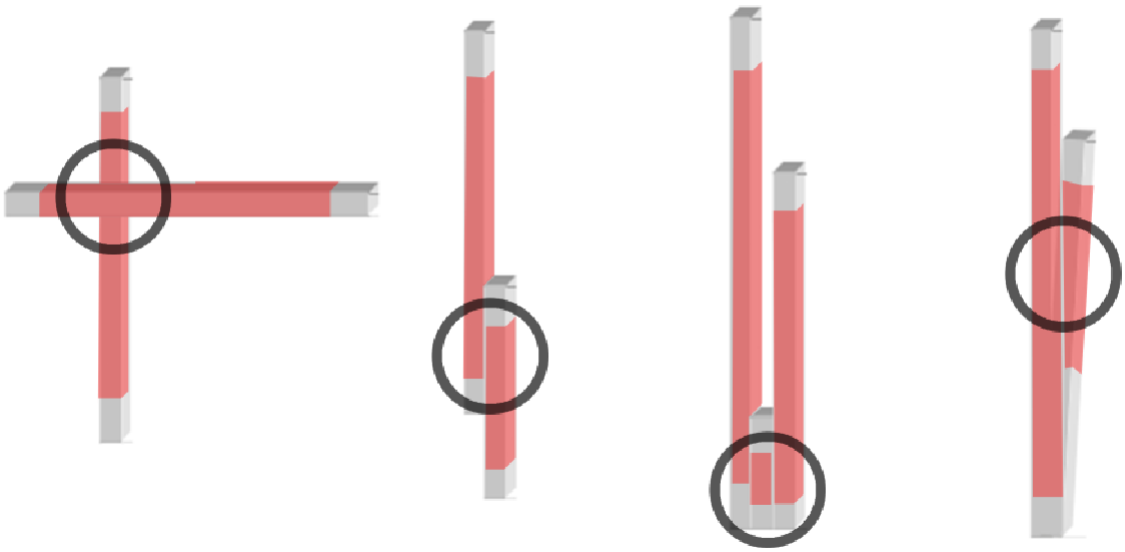
GENERAL RULES #3:

Joints within the 1/4" of the end of at least one of the sticks (members).



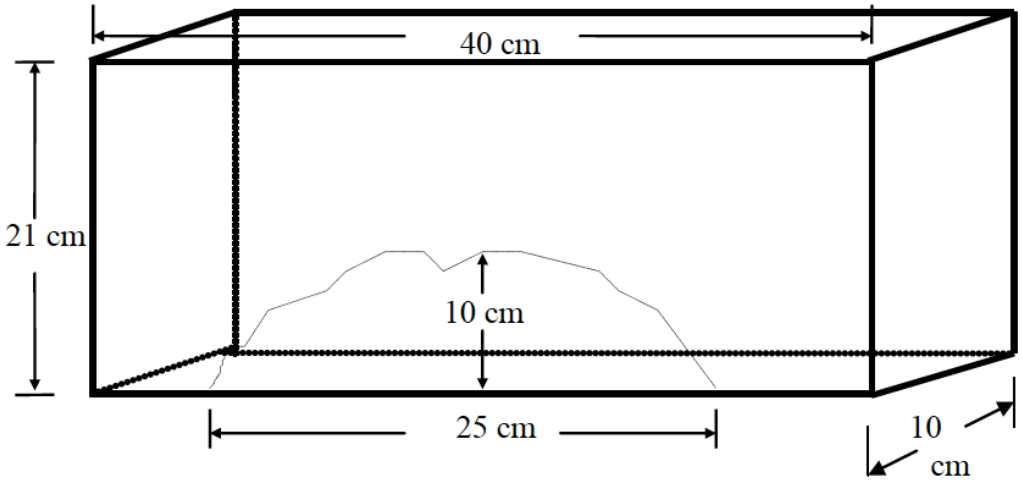
Areas in green are the cleared areas for joints within the 1/4" - figure not shown to scale.

Following joints are not within the 1/4" of the end of at least one of the sticks (members).



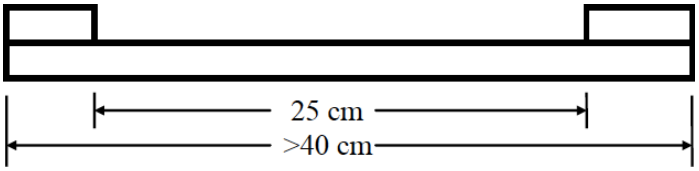
B – Testing Setup & Apparatus

1) Figure 1a: Overall Dimension Test: The bridge must fit inside a box with the following dimensions to be considered legal; bridge must also pass the 10 cm clearance test.

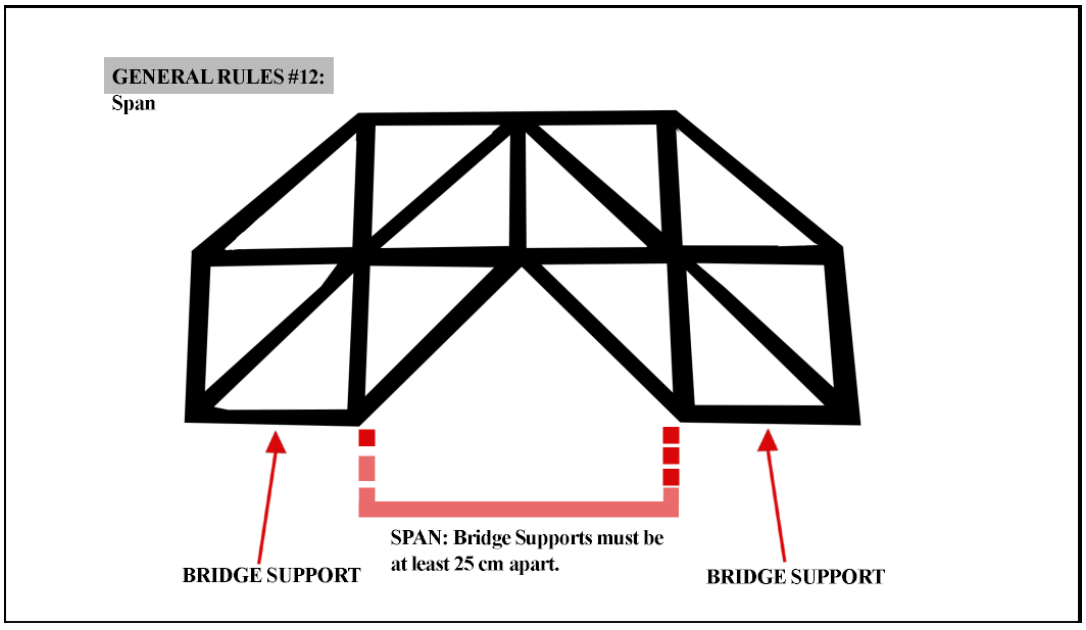


The bridge must clear the 10 cm line at at least one point (above an "imaginary river") in the 25 cm span.

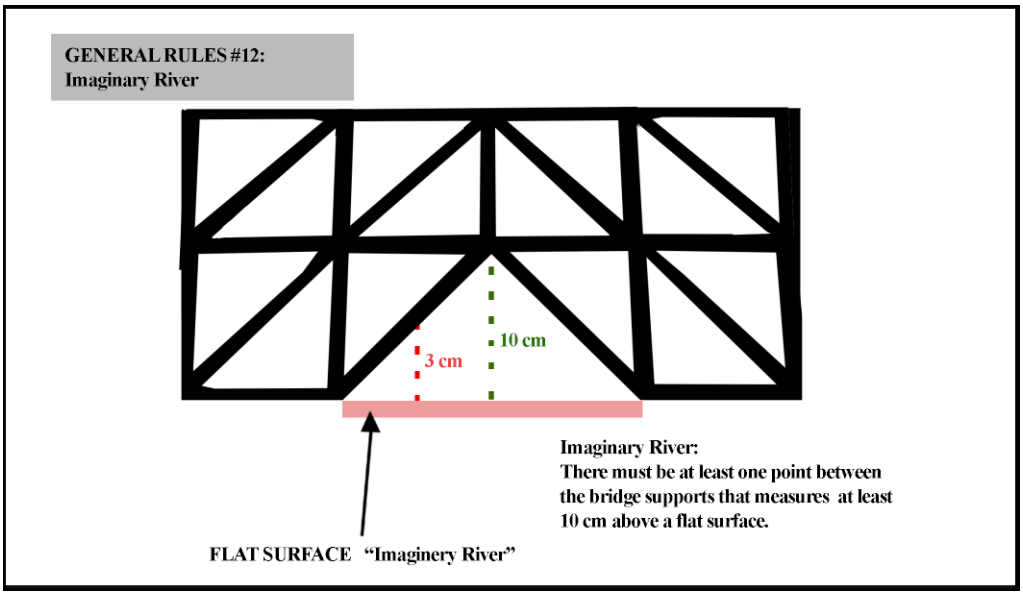
2) Figure 1b: The bridge will be supported on both of the blocks as shown:



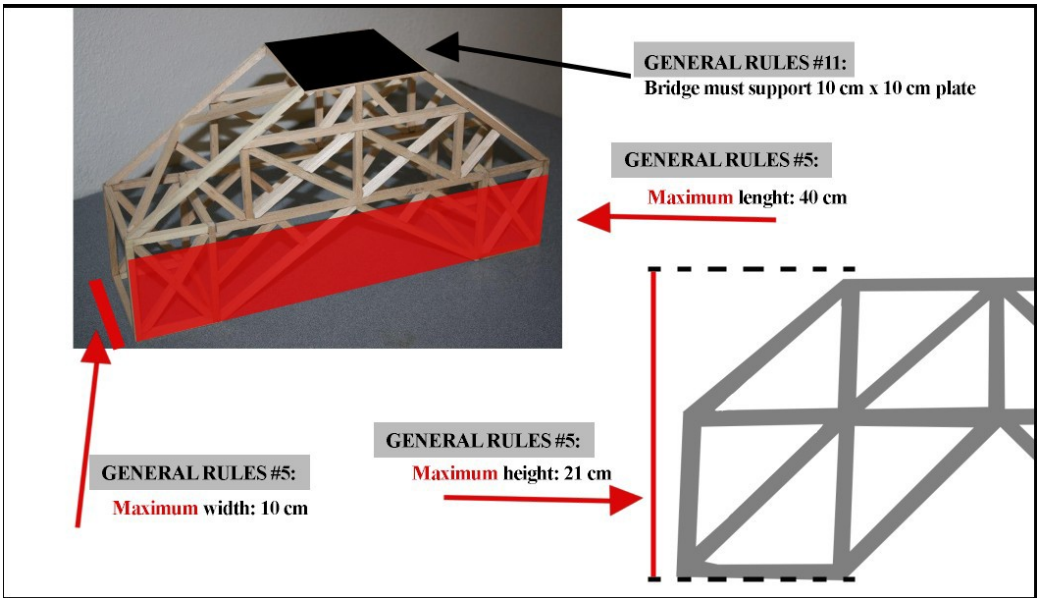
3) Figure 1c: Span clarification between bridge supports.



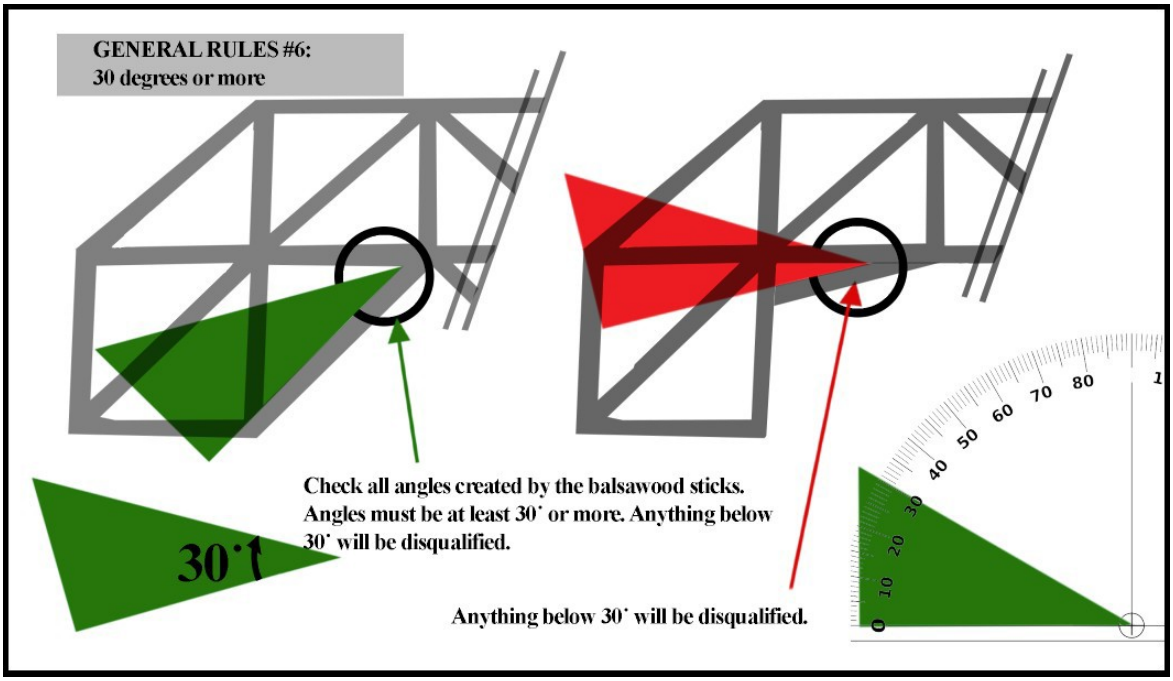
4) Figure 1d: Imaginary River and clearing the 10 cm line.



5) Figure 2: The bridge is tested for strength by applying weight (force) to a 10 cm square plate placed on top of the bridge. The bridge is tested for strength while sitting on the blocks. Additionally, note dimension details in the figure below.



6) Figure 3: Members joined at an angle must be at an angle of 30 degrees or more.



C – Clarification of Gluing

- The spirit of the gluing rule is to allow bridges made of balsa ***ONE LAYER*** thick. Since the balsamay need to be overlapped at the joints, the bridge may need to be more than one layer thick at the joints.
- Rule for Construction #1 states: **"Joints must be at or within ¼" of the end of at least one of the sticks (members)**. No part of a stick may be glued to another stick except at the joints of sticks. (i.e., gluing is very limited). (**See ATTACHMENTS/APPENDIX – Sample Joints)**
- Since dry glue is nearly invisible and it is impossible to tell what part of overlapping members is glued and what part is not, judges must assume that the entire length of overlapping members is glued. Therefore, no two members anywhere on the bridge may overlap by more than ¼".
- ¼" long pieces of balsa may be used as "spacers." A spacer is defined as a piece whose sole role is to separate structural members (such as at the corners of the bridge).
- Wholly glued pieces which appear to strengthen, reinforce, serve a purpose other than separating, or are placed too closely together will be considered lamination, not spacers.
- Determination of what is a spacer and what is excessive gluing will be left solely to the judges. Since this may be a "gray area," with disqualification as a possible result, students are encouraged to avoid the use of spacers.
- Please remember that the purpose of this contest is to use creativity to build the best structure within the framework of the rules. The purpose is not to break the rules and see if you can get away with it.

D – Specification Checklist

**Note: As the name above implies, this list is intended simply as a guide for meeting the required competition specs. It should not be treated as an official judging document.*

- q Bridge is properly labeled with team members names, school, and MESA Center
- q Material is ¼" x ¼" balsawood
- q Glue is water soluble Elmer's-type white glue
- q Maximum length ≤ 40 cm
- q Maximum width ≤ 10 cm
- q Maximum height ≤ 21 cm
- q Minimum clearance above "river" ≥ 10 cm
- q Minimum Span ≥ 25 cm
- q Maximum Bridge weight ≤ 95 grams
- q All joints are at or within ¼" of end of one member
- q No glue beyond 3mm from any joint
- q No excessive gluing (i.e. members are glued only at the joints)
- q All members joined at an angle $\geq 30°$
- q No pins or gussets used
- q Balsawood is not painted or treated
- q Top center of Bridge has 10 cm x 10 cm area for placement of the test plate
- q Bridge has supports suitable for placement on testing fixture

ENGINEERING LAB BOOK REQUIREMENT RUBRIC

Please use this rubric to assess lab book entries. An **incomplete** lab book (i.e., missing 1 to 2 specified criteria) will lead to a 20% deduction from the total project score. A **missing** lab book (i.e., not submitted OR missing 3 or more specified criteria) will lead to a 50% deduction from the total project score and will make team ineligible to place.

Criteria		YES	NO
	Is the lab book properly labeled? *(Names, Grades, School, MESA Center)*		
1	Identify the Need (at least 2 sentences for each) *State what is the challenge being worked on? What are the limits/constraints? How do you think you can you solve it.*		
2	Explore *Conducting research (listing 5 cited/referenced sources), gathering materials, try using materials*		
3	Design *Brainstorming ideas (at least 3 iterations) each represented by a picture, sketch or drawing. Creating a plan for selected idea (at least 5 sentences). A list of materials for the prototype.*		
4	Create *Building a prototype. Describing the building of the prototype (at least 5 sentences). Including a final picture of the project.*		
5	Try it Out *Testing idea/prototype. Attempting at least 3 trials/attempts. Measuring each trial result (by specific performance criteria like distance traveled, time, etc.). Providing evidence of the use and application of at least 2 appropriate*		
6	Make Better *Evaluate results. List at least five ways project can be improved*		
	TOTAL		
	Lab Book Complete (mark with X)		

Is this considered an **incomplete** lab book – missing 1 or 2 criteria listed?..... **NO** **YES** (-20%)

Is this considered a **missing** lab book – missing 3 or more criteria listed? ..... **NO** **YES** (-50%)