**IHM Physics Challenge Club - Bridges**

**Bridge Specifications & Rules**

1. Bridge must be constructed only of the provided 100 wood splints and any type of glue. You are NOT required to use all 100 splints.
2. Bridge must span a 24 CM gap. \*Make your bridge somewhat wider than this or it will “fall in”!
3. Bridge must include a passageway/roadway that is at least 4 CM wide and 3 CM high.
4. A standard Hot Wheels/Matchbox car must be able to roll across the entire length/roadway of the bridge.  Two splints about 1.5 CM apart and the length of the bridge will suffice for a “roadway”.
5. Roadway surface may be a maximum of 1 CM above the ground level.

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| 1. Bridge may only rest on the “ground level” which is the top of two blocks of wood that are 24 CM apart. Bridge may not touch the “valley” in the gap below.
 | F:\Bridge ground.png |
| 1. Bridge testing/breaking force will be applied through a pair of hinged/connected 4.4 CM by 6 CM blocks of wood, 2.6 CM apart, placed on the center of the top of the bridge.
2. Top of bridge must be: flat, at least 15 CM long and 4 CM wide.
 | F:\Bridge weight.png |

1. No portion of the bridge may be higher than 6 CM above the ground level.
2. No portion of the bridge may be lower than 1 CM below the ground level.
3. Bridge may be no wider than 10 CM
4. Bridge must be completed by Tuesday October 26th

**Judging – Classes – Display**

Bridges will be weighed before they are loaded/broken. The primary goal is to build a bridge that holds the greatest multiple of its own mass. A 30 gram bridge that holds 30 KG will be considered more successful than a 60 gram bridge that holds 45 KG. Watch out for excess glue outside of wood joints; it tends to add much mass but little strength. Don’t overbuild the roadway, it only needs to hold a Matchbox car.

Students may: work on their own, with another student or with an adult/older sibling. Students who work with an adult/older sibling must do at least half of the construction work and must understand every element of the design - this should be a learning experience. This is a competition, but bridges by students who work with a parent will not be compared to bridges made by students working solo, etc.

Broken bridges will be on display in the computer lab until the November meeting.

**Wood and Beams**

Your wood splints are; 1.3mm Thick X 6.5mm Wide X 140mm Long. This means that the splints have a 5X width to thickness ratio.

**Compression** (squishing together) - Under compression a full length single splint is very weak. It will buckle/bend/break around a 1 pound load. Glue two splints together to form a T shape and they will hold at least 30 pounds under compression. Beams can also be formed by gluing three splints together into an I shape (wide flange really:  ), four splints into an X or box shape or three or four flat together into a solid beam. If you use single splints as compression beams your bridge will likely fail early. Take the time to construct T or other beams.

**Grain** (lines through the wood) – Carefully look at the grain of your splints. Wood is strong with the grain but is weak across the grain.) Avoid cross grain forces! Splints with straight grain running lengthwise will be the strongest. Avoid using cross grain or irregular splints. You do not have to use every splint so avoid “the weakest links”.

**Tension** (pulling apart) – Wood is extremely strong under tension. Length and beam styles are not critical because buckling is not an issue with tension as it is with compression. Lengths of straight grain wood are generally much stronger under tension than compression. In your bridges, a single splint will probably not fail under tension.

**Triangulation** – Form triangles wherever possible. Look at how radio antenna and trestle bridge are built. Lots of small triangles helps prevent buckling and yields great strength.

**Joints** – Joints are a likely place for your bridge to fail. Reinforce all joints with layers. Short pieces of splint overlapping both pieces of a joint will help prevent failure.

**Recommended Glues**

**Wood glue** is: strong, reasonably light when dry, easy to clean up after and is inexpensive but it has slow drying time.

**Epoxy** is: also very strong, cures faster than wood glue, but is more expensive and messier.

**Cyanoacrylate** (super-glues) are: very strong and have the shortest curing time, but are expensive. There are hundreds of name brands and thick through thin. Hint: use a thin cyanoacrylate and fill gaps with a light dusting of baking soda. Avoid gluing your fingers together on to the wood! This can happen in seconds. Nail polish remover (acetone) dissolves cyanoacrylates and will free your fingers.

**Research** – Research the terms: bridge, truss, beams, toothpick bridges, etc. The more you study before you design and build, the better your bridge will be. Feel free to bounce ideas off of Mr. Hall or Mr. large or even better talk to a relative or family friend who is an engineer.

**Plan Your Bridge:** Draw your bridge in Paint.NET; I have a scaled multi layer template available on IHM.NET. Or, draw your bridge on the paper template provided. Be careful not to use more than 40 splints per bridge side. You will need two sides and they will need to be connected together at the ground level and at the top.