**BALSA BRIDGE PROJECT GUIDELINES**  Physics 2015-2016

In this project, you will be constructing a bridge using balsa wood and carpenter’s glue. No other supplies can be used in the construction. Your objective is to design and construct a bridge that can span a distance of at least 40 cm and allow for a matchbox car to travel across. The strength of your bridge will be evaluated by comparing the weight that it can suspend to the mass of the bridge itself. Your goal is to design the strongest bridge with the smallest mass. Your bridge will be tested in class.

Design:

* Can use a maximum of 10 sticks of balsa wood and carpenter’s glue, no other supplies.
* Must be a minimum of 35 cm long.
* Max height – 21 cm Max Width 10 cm
* Must allow for a Matchbox or Hot Wheels car to cross.
* The total mass of the bridge plus glue must not exceed 100.0 g.
* No other material other than balsa wood and glue may be attached to final product.
* No fastening mechanism except mechanical interlock of the balsa pieces or commercial glue is permitted.
* The bridge shall be "free standing".

Testing

* The bridge pedestals shall be placed on level surfaces separated by approximately 35 cm. These surfaces shall be level with respect to each other.
* The standard test frame will be placed on the roadway over the centre of the bridge span. The load applied to the bridge shall be suspended from a single 1/2 " diameter rod placed in the centre of your bridge.
* A container shall be suspended from the load-supporting frame. To this container (which may be pre-weighted with steel weights as warranted in the opinion of the judge(s)), water and/or steel weights shall be added at a slow, steady rate, until either an audible cracking sound together with visual evidence indicates the failure of some structural member or glue joint of the bridge, or until a suitable reference point on the roadway at the centre of the span has been lowered by more than 2.0 cm. A competitor may not participate in the addition of weight to his/her own bridge. All decisions of the judge(s) are final.

Reporting

* Detailed sketch of bridge on graph paper with dimensions clearly labeled.
* Calculation of the maximum force applied to the bridge at the moment it breaks.
* Calculation of the strength-to-weight ratio ( $\frac{Mass Supported}{Mass of Brdge}$)
* Lab Report



### Bridge Building Tip Sheet

* Use a small balsa wood saw (about $3) instead of an exacto knife to make cuts (that is all on you)
* Cut small notches to connect bridge components
* Use a basic carpenter's glue
* Yellow glues contain aliphatic resin, used in the majority of winning bridges
* Fewer pieces mean fewer problems
* Clamp glued pieces for about half an hour (use protective strips to avoid damaging the balsa). If you don't have any clamps you can use clothes pegs. C-type clamps are available quite inexpensively at Canadian Tire
* Design for strength at the load application point
* Construct roadway of thin, narrow strips of balsa
* Don't glue down ends of road ways…they usually bend upwards under load
* Roadway must support a small Hot Wheels-type car
* Most bridges bend inwards (as viewed from one end); consequently they require horizontal bracing
* Write your team number prominently on a main horizontal beam of your bridge and on both sides of the bridge
* Do not cover your bridge with any material. Glue should be used only to join components
* Use light sandpaper (number 150 or higher) to gently clean your bridge and remove excess glue
* Some common mistakes:
	+ Using a single sheet of balsa for roadway (solution: cut into strips)
	+ Making outside width 5.0 cm instead of inside dimension
	+ Making overall length 40 cm instead of span (between pedestals)
	+ Not allowing room for bolt(s) on test frame
	+ Your bridge will lose weight as it dries (common sense???

Two 36" sticks of balsa wood 1/8" square may weigh as much as 4 grams, or as little as .5 grams.  Also, balsa wood absorbs water from the air.  Dry wood weighs less, wet wood weighs more.  Think about ways you could get the structure to lose some of the excess water.

Look extremely close at a stick of balsa wood: Do the grain lines run parallel with the edges of the stick, or do they cut diagonally across the stick?  Believe it or not, but this does make a substantial difference in how much weight a structure can hold.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Category** |  |  | **Points Received** |  |  | **Points Possible** |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Design** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | Bridge meets construction requirements |  |  |  |  |  |  |  |
|  | o wide enough to allow car to pass |  |  |  | 5 |  |  |
|  | o | allows car to roll across |  |  |  |
|  |  |  |  |  |  |  |  |
|  | o long enough to rest on support structures for testing |  |  |  |  |  |  |  |
|  | Creativity |  |  |  | 5 |  |  |
|  | o | bridge has unique characteristics or is an original design |  |  |  |
|  |  |  |  |  |  |  |  |
|  | Quality of craftsmanship |  |  |  |  |  |  |  |
|  | o | wood cut to appropriate length |  | 5 |  |  |
|  | o limited glue used at joints |  |  |  |  |  |  |  |
|  | **Report** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | Neat and detailed drawing of bridge |  |  |  |  |  |  |  |
|  | o drawn on graph paper |  |  |  |  |  |  |  |
|  | o | all dimensions clearly labeled |  | 10 |  |  |
|  | o use of straight edge |  |  |  |  |  |  |  |
|  | o | drawn to scale |  |  |  |  |  |  |  |
|  | Organized recording of necessary data |  |  |  |  |  |  |  |
|  | o | mass of bridge |  | 2 |  |  |
|  | o mass held before breaking |  |  |  |  |  |  |  |
|  | Calculation of force applied to bridge |  | 5 |  |  |
|  |  |  |  |  |  |
|  | Calculation of bridge efficiency (strength-to-weight ratio) |  |  |  | 5 |  |  |
|  |  |  |  |  |  |  |  |  |
|  | **Group Participation** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | All group members worked cooperatively to produce bridge and |  |  |  | 3 |  |  |
|  | report |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Bridge and report completed on time |  |  |  |  |  |  |  |
|  | o effective use of class time |  |  |  | 10 |  |  |
|  | o | research completed before construction began |  |  |  |
|  |  |  |  |  |  |  |  |
|  | o work completed outside of class if necessary |  |  |  |  |  |  |  |
|  | **TOTAL** |  |  |  |  |  | **50** |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

**Rubric**