SCIENCE WORLD at TELUS WORLD of SCIENCE

Project Notes -- Assembly & Program Material (Updated)

Date:	Dec 2013 – Jan 2014	**Project:**	Keva - Trebuchet
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This project can be exciting all along the way and foster learning both in assembly of the Trebuchet, as well as having the thrill of flinging objects into space – geometry to physics!

Here are our notes about:
1. Assembling, and 2. Program Material – "Exploring/Learning through the Trebuchet".
These notes on experiences and explorations may help you as you consider your programming.

I. Assembly Notes & Troubleshooting:

Generally, assembly was not difficult. We made sure we had time for the glue to dry before going on to the next steps. In a few places we used clamps on places that would endure the most stress, like the columns. Following are some additional notes/troubleshooting that may help you. The items are for a few of specific steps along the way.

- **Using Correct Planks** – ***Particularly Construct Chute Guide & Swing Arm Construction***
  Most of the Keva planks are basic, interchangeable ones. Note, however, the "Contents" section on the Instructions (upper left) which lists planks with different size holes and different placement of holes. Make sure to distinguish between Planks D & E. They both have small holes placed differently.

- **Chute Width** – ***Step B: Construct Guide Chute***
  Note that the Chute is 2 planks wide. If it is only one, the ball will not sit in it properly, resulting in misfiring. We used 2 stacked planks to provide additional support the centre of the Chute.

- **Inserting Release Pegs** – ***Swing Arm Construction*** *(Step 3)*
  If a peg is a tight fit, try either end in each hole. You may need to shave them slightly.
  In the version we assembled we ended up with a slight crack. Note one of the pegs (the upper one) is at an angle.

- **Stability** –***Assemble the Trebuchet Frame*** *(Step 1 - 2)*
  When you assemble the base of the frame, you find 2 sides are glued onto the other 2 sides. This means that 2 sides supporting the vertical frame *do not* rest on the ground. As there are "extra" Keva pieces we used 2 of them as additional support under the sides where the columns are attached to the Trebuchet Frame.

- **Placement of Washers** – ***Trebuchet Assembly*** *(Step 2)*
  Make sure that the Swing Arm will sit in the centre between the support columns.
  The washers will help with placement. You may want to have 2 sets of hands for this part of the process.

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II. Exploring/Learning Through the Trebuchet (Notes from Trials):

A. Experimental Design

- **Choosing a good space.** There are several factors to consider: Safety for participants; Ergonomics (you); and Room to "fling" imperviously!
  - *Safety is a vital part of your set up.* Make sure beforehand that there is room for everyone to get out of the way of the Trebuchet. Make the "boundaries" clear to everyone at the time. *Make sure they do get out of the way!*
  - You'll be making adjustments, adding things and taking them away from the Trebuchet. So if possible, place the Trebuchet where you won't have to be constantly bending over it or twisting yourself to reach it.
  - Avoid being near windows or other items that may not like being hit (the objects you're choosing shouldn't be too hard or fragile). The ceiling and distance in front of you should be far enough away for the object not to hit or bounce off it immediately. If you use only the provided kit balls, it will likely be safe.
    Tips: Identify a group of spotters who see where the object landed. You can also place tape measures on the ground to see where the object first landed.
- **Trebuchet Set-up.** Correct placement in the Sling Pouch & appropriate tension in its strings is vital for success. ***Note:*** The Sling Pouch has a ring that slides over the Release Peg! ***Choice of Objects:*** *With the Kit's balls, we found about 50% launch success rate. Corks (e.g., a non-spherical object) were tried & appeared to have a potentially higher success rate.*

Tips: Make sure the object sits properly in the Sling Pouch (i.e., symmetrically and mainly covered by it). Also make sure you have pulled the Pouch as far as it can go in the Chute. It should sit in the centre of the Chute since the object is intended to slide through the Chute unimpeded and guided straight.

B. Steps

Each time you do an experiment with the group, write down the following:
(This table is a very simple example of what you can do):

Our Variables	Predictions	Outcomes
Weight: Height: Release Peg: ❒ Angled ❒ Straight Object: Other: Weight: Height: ❒ Release Peg: ❒ Angled Straight Object: Other:		

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C. Our Notes

We hypothesized about 2 aspects: *(See suggestions in Trebuchet's Instructions/Directions.)*

1. **Varying Counterweight:** The greater the counterweight the farther the object usually goes (Proved to be the case)
2. **Height for Launching:** Choice with respect to height consists of selecting the release peg and placing the ring on that choice (straight or at an angle) (Proved to be the case)

1. **Varying Counterweights**
   a. 50 pennies
   b. 50 pennies + 8 quarters

Tips: Recycled batteries may offer a good alternative to using coins.

- *Advanced version:* To add some precision, weigh a battery and then keep adding the same kind of battery into the counterweight tray to experiment with weight.
- *Learning about weight:* For a younger audience learning about different objects might be part of the lesson, so using a variety of objects may be most appropriate.

2. **Height for Launching**
   a. Angled Release Peg (upper)
   b. Straight (lower)

Tip: We found that, depending on the variables, the object could be released early. That was particularly the case when using the Straight Release Peg (lower peg). This resulted in the object being flung "backwards". *Remember that as part of your safety check!*

3. **Key Learning Concepts:**
   a. Use of Momentum
      The aim is that the Sling Pouch won't let go until the object is going in the desired direction. *Possible question:* Does it matter how long the ball stays in the pouch?
   b. Mechanics
      The Trebuchet consists of more than one "machine" including an axel and lever. *Possible questions:* What is a machine? What kinds of machines make up the Trebuchet?

D. Additional Ideas for Learning

Other things you might draw attention to and discuss:

- ***Physics*** – Conservation of energy and inertia; Difference between mass & weight.
- ***Geometry*** – What is the angle of release? How critical is it to know this angle for accuracy? What if anything would you measure?
  Note: The labels for targets in this kit are available to be created and set up.
- ***Mechanics*** – See the question in "Key Learning in Concepts". Other possible specific questions may be asked, like, what are washers for? How can they be used effectively?