

# Catapult

**Category:** Physics: Force and Motion

**Type:** Make & Take

**Rough Parts List:**

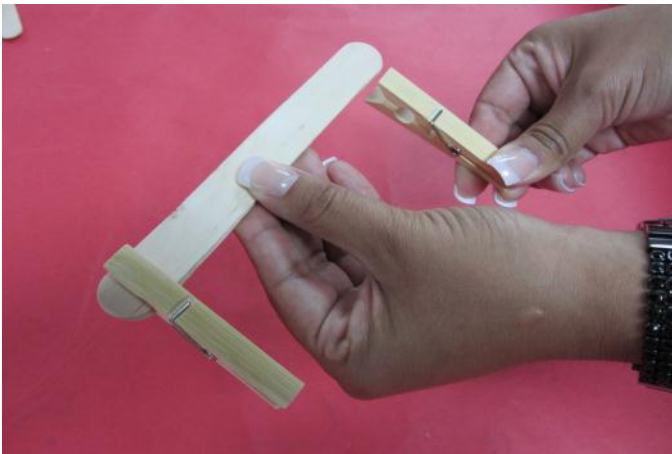
5	Jumbo craft sticks or tongue depressors
1	Binder clip
2	Clothespins
1	Spoon
2	Small pieces of wood, i.e. paint paddles
	Marbles, beans, puff balls or other objects to catapult

**Tools List:**

Hot glue gun

**Video:** <http://www.youtube.com/user/FresnoCSW>

**How To:**



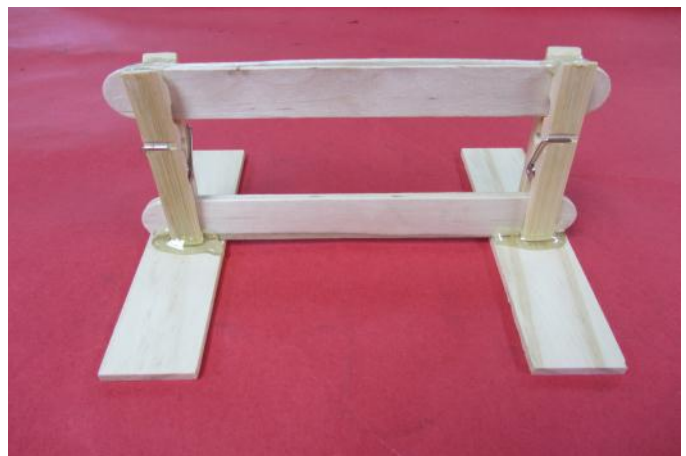
Place 2 craft sticks in the clothespins.



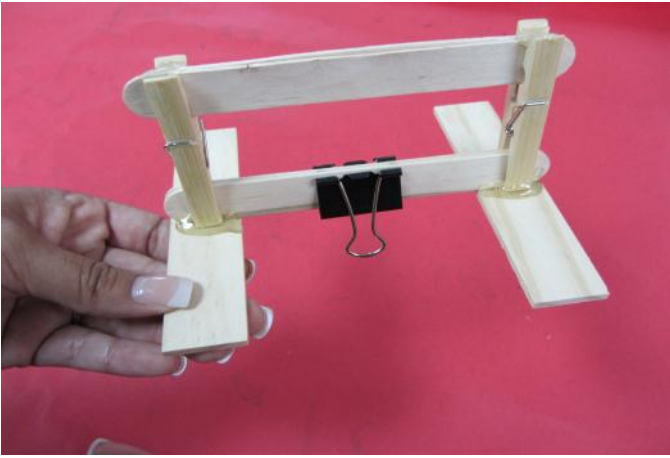
Slide 3 craft sticks into the opposite end of the clothespins.



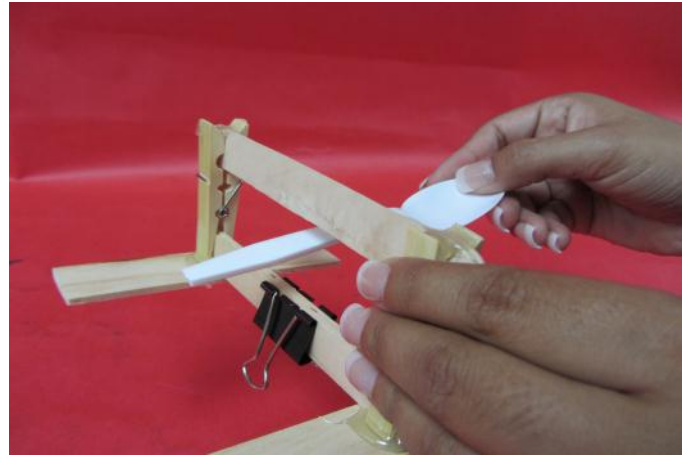
Glue the top of each clothespin.



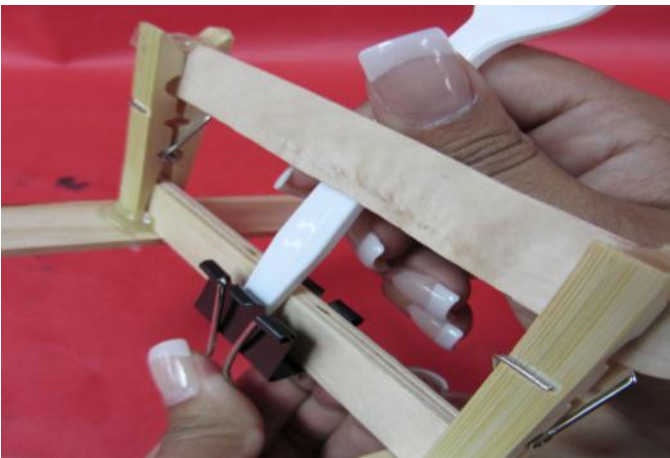
Glue the end with 3 craft sticks to a base.



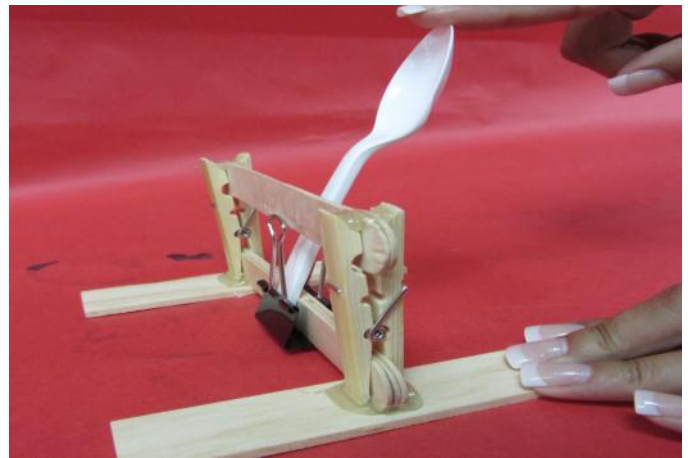
Clip the binderclip to the 3 craft sticks.



Slide the spoon between the two sets of craft sticks.



Open the clip and insert the spoon.



Place a bean or marble in the spoon, aim the catapult at a target, and fire!

### Fine Points:

- Small craft sticks may be used instead of large sticks.
- A cardboard base can be used instead of two paint paddles.
- Secure the base by either holding it or placing a heavy object on it while catapulting items.
- With small blocks of wood or other materials, you can prop up the front end of the catapult base, thus changing the launch angle. Then you can find out which launch angle is the best for distance.

### Concepts Involved:

- A force is a push or a pull.
- A pulling force on an object is called tension.
- Different launch angles will give different paths for the projectile. There is one optimal angle that will make the projectile fly the greatest distance.
- Different projectiles will encounter varying air resistance and will shoot different lengths.

### Focus Questions:

1. What could you do to make the catapult shoot further?
2. How can you create more tension on the spoon? Less?
3. Would the catapult shoot further with a longer arm, or a shorter one?
4. How would you hold or set the catapult to make it shoot straight up?

5. How would you hold or set the catapult to make it shoot as far as possible?
6. Gather lightweight objects such as Styrofoam and pom-poms, mid-weight items such as little paper balls and heavyweight objects including beans and pebbles. Compare the flight path of all items thrown at the same angle. Which items flew highest? Furthest?

### **Elaboration:**

Tension is a pulling force from one item acting on another. In this case, pulling on the spoon creates tension in the spoon's handle and the black metal binder clip. When the spoon is released, the elasticity of these two things pulls the spoon forward. Hitting the craft sticks stops the motion of the spoon, but the projectile continues moving and leaves the catapult. This is an example of Newton's first law of motion: An object in motion tends to stay in motion, and an object at rest tends to stay at rest. The motion of the projectile will continue until it hits something, which will give it a force to stop it. If it never hits anything, (if you launched the object in outer space) it would continue moving forever.

Catapults were created to do one thing - throw large objects over a long distance. Throwing large objects usually takes a large amount of force. Levers give us mechanical advantage to lift and throw heavy items. The spoon's handle creates a lever.

According to theory, the best release angle for getting a long distance flight is  $45^\circ$ . Anything more or less than  $45^\circ$  will result in a shorter flight for the projectile. Check to see if your catapult follows this theory: elevate the front of the base until it is about  $45^\circ$  - halfway between flat on the ground and standing up vertical - and see if it throws the furthest.

### **Links to k-12 CA Content Standards:**

#### Grades k-8 Standard Set Investigation and Experimentation:

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

#### Grades k-12 Mathematical Reasoning:

1.0 Students make decisions about how to approach problems:

1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:

1.1 Use estimation to verify the reasonableness of calculated results.

1.2.2 Apply strategies and results from simpler problems to more complex problems.

1.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.

2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:

3.1 Evaluate the reasonableness of the solution in the context of the original situation.

3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.

3.3 Develop generalizations of the results obtained and apply them in other circumstances.

### Grade 2 Standard Set 1. Physical Sciences:

The motion of objects can be observed and measured.

- 1.a Students know the position of an object can be described by locating it in relation to another object or to the background.
- 1.b Students know an object's motion can be described by recording the change in position of the object over time.
- 1.c Students know the way to change how something is moving is by giving it a push or a pull. The size of the change is related to the strength, or the amount of force, of the push or pull.
- 1.d Students know tools and machines are used to apply pushes and pulls (forces) to make things move.

### Grade 3 Standard Set 1. Physical Sciences (Energy & Matter):

- 1.c Students know machines and living things convert stored energy to motion and heat.
- 1.d Students know energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

### Grade 8 Standard Set 2. Forces:

Unbalanced forces cause changes in velocity.

- 2.a Students know a force has both direction and magnitude.
- 2.e Students know that when the forces on an object are unbalanced, the object will change its velocity (that is, it will speed up, slow down, or change direction).
- 2.f Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion.

### Grade 9-12 Physics Standard Set 1. Motion & Forces

Newton's laws predict the motion of most objects.

- 1.b Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's First Law).