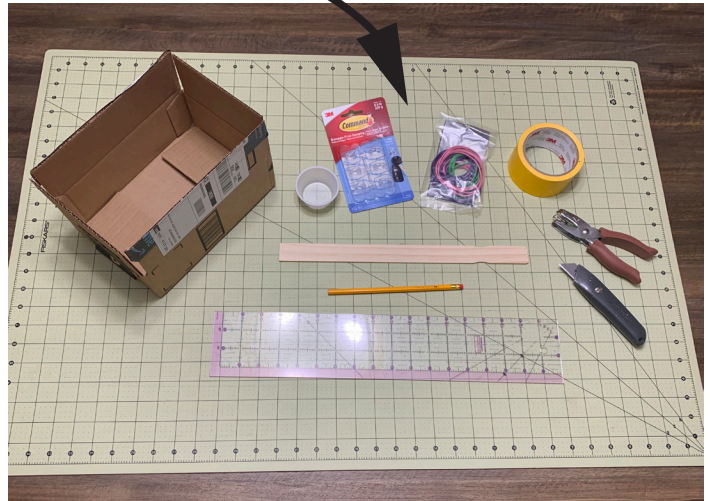
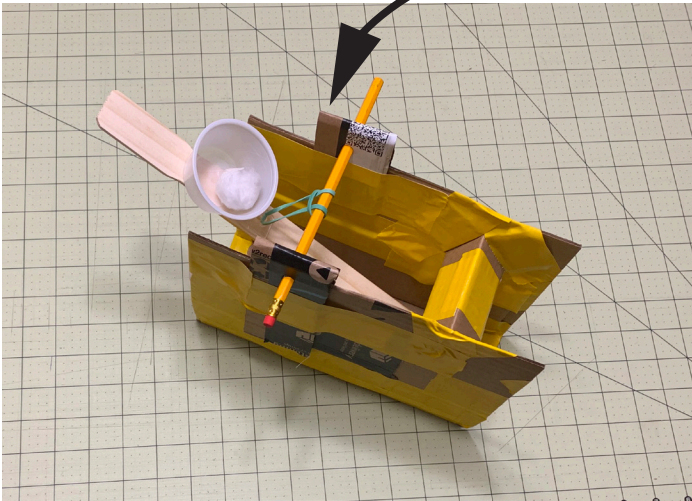


Want to make THIS from THAT?

see pages 7-9 for alternate making instructions using larger pieces of cardboard



Catapults are a cool way to study a simple machine that converts potential energy into kinetic energy. There are some nice kits on the market that allow you to build your own... if they're in stock.

But, we're channeling our inner *MacGyver* / engineer, so guess what? We can make do with a bit of cardboard, some duct tape, and a few other things.

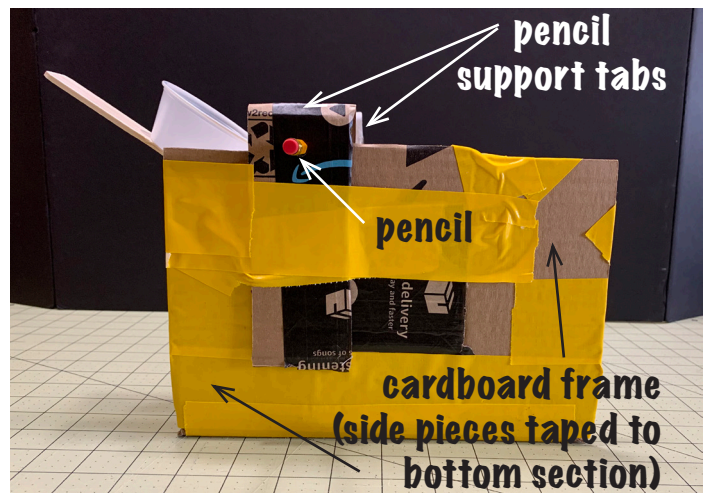
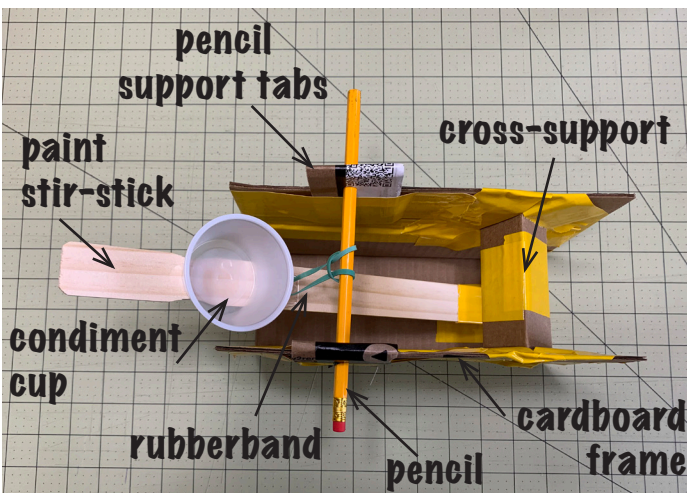
Are you game?

Let me show you where we're headed... it will make it easier for you to follow along (detailed photos!)

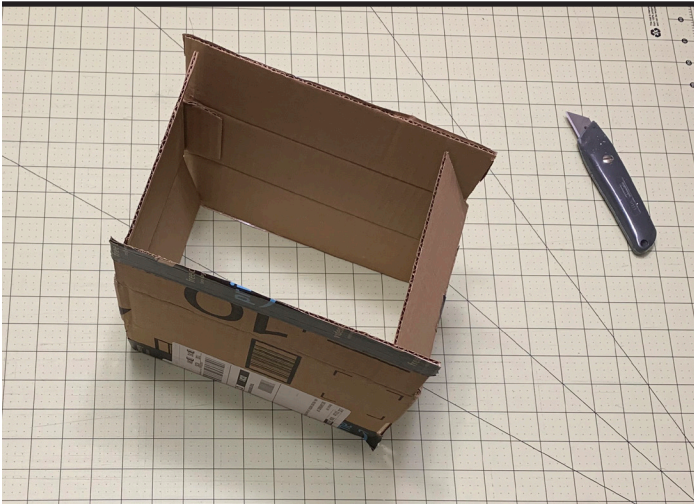
Suggested supply list

(feel free to improvise):

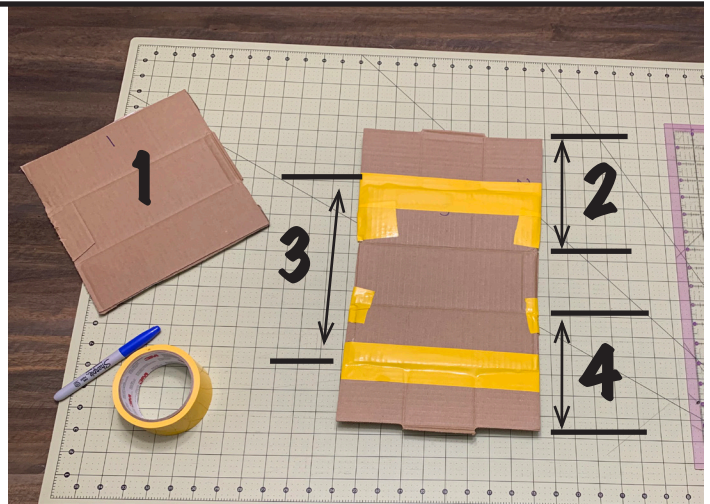
- small cardboard box (~9 x 6 x 3.5 in. used here... but there's a lot of flexibility here)
- wood paint stir stick (~1 in. by ~14 in.)
- small plastic condiment cup or yogurt cup
- rubberband
- pencil (preferably unsharpened)
- duct tape
- plastic hook (3M Command brand used here)- used to attach rubberband to paint stir stick



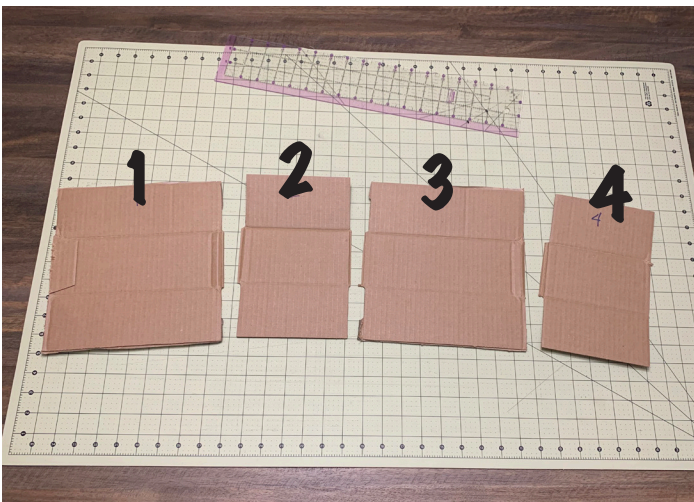
Notes on working with cardboard: 1) use **corrugated** cardboard. Those little triangles between the outer layers provide structural support. 2) A **bend** in cardboard is like a **hinge**. We'll use the bends in our box strategically to form the bottom and lower side section of our catapult structure, and the cross-support. There are a couple places where we'll have to **score** the cardboard to **make a new hinge**.



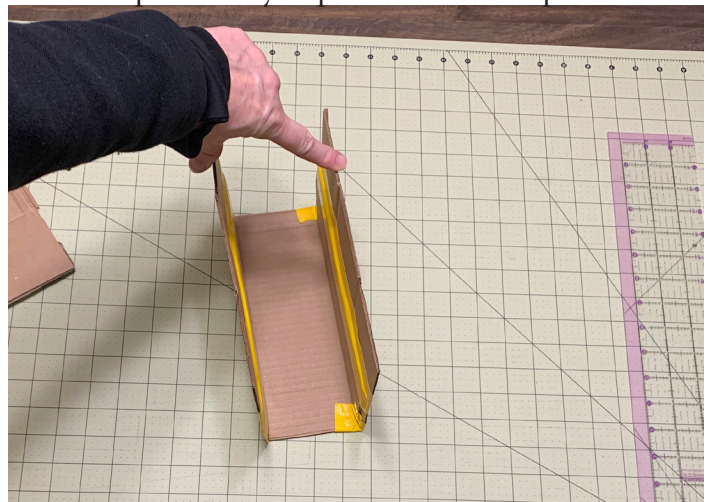
1) Cut open the bottom of the box



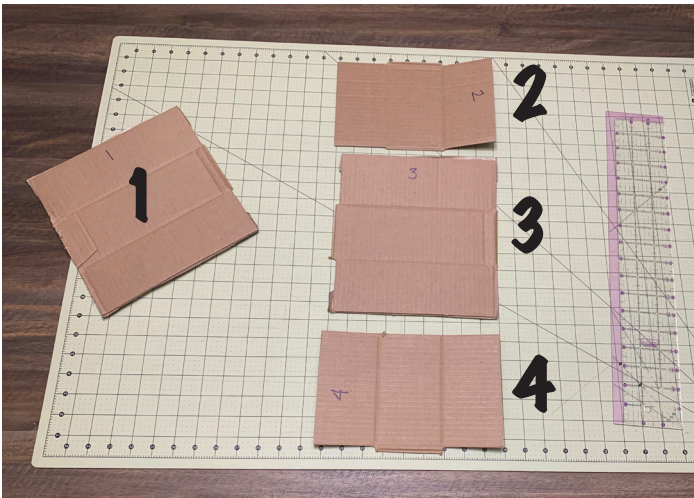
4) Overlap pieces 2 & 4 on the outside of piece #3 and tape securely in place with duct tape



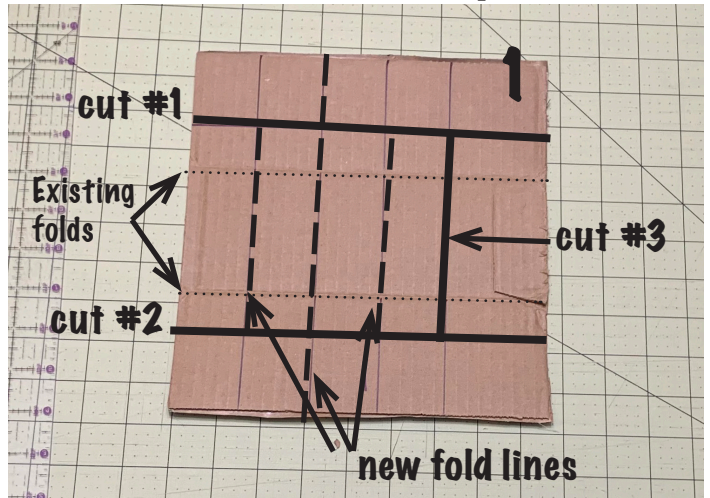
2) Cut each of the sides open. You'll have two longer pieces (#1, 3) and two shorter pieces (#2, 4)



5) Cardboard frame shown with sides folded up. Note shorter inside section from piece #3.

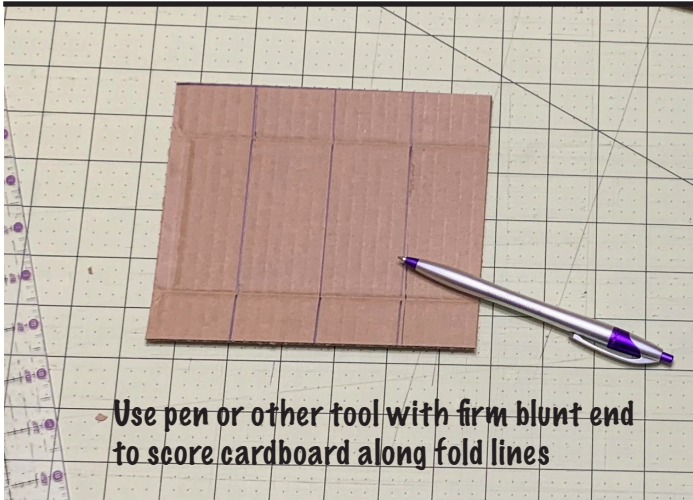


3) Arrange pieces as shown. #3 will form the base of the structure, #2 & 4 will be taped to the outside.



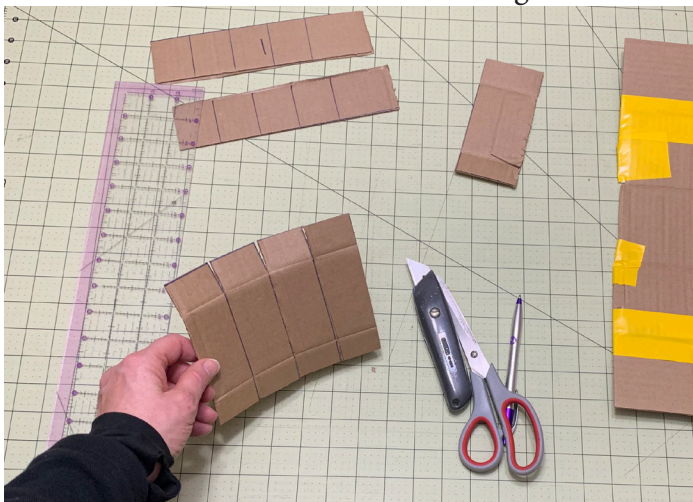
6) Take piece #1 and make cuts as shown, about 1 in. from existing folds. Score cardboard along fold lines.

Tools needed: a utility knife and/or scissors, straight edge for cutting, cutting mat or piece of cardboard to protect work surface, hole punch (optional), pen or firm but blunt object to score cardboard for bending. If you don't have a hole punch, cut a small 'X' in the cardboard and push the pencil through. It should hold it in place fine.

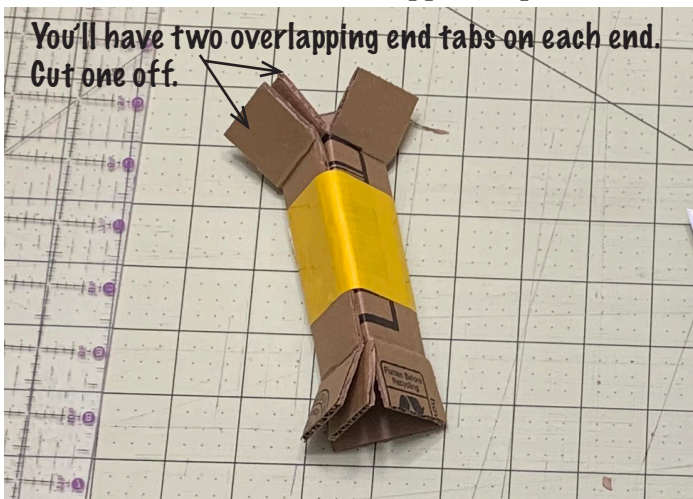


Use pen or other tool with firm blunt end to score cardboard along fold lines

7) Score but do not cut through cardboard along fold lines. Bend cardboard to make 3 hinges.



8) Clip ends to fold. We'll tape these flaps to the frame to secure the cross-support in place.



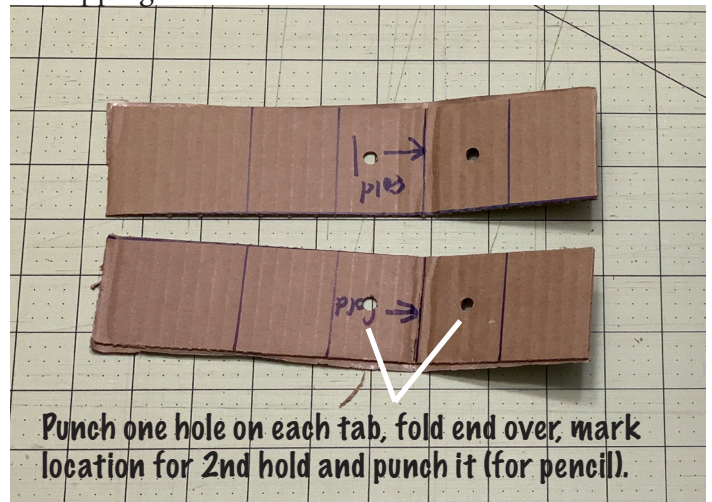
You'll have two overlapping end tabs on each end. Cut one off.

9) Fold into triangular cross-section, overlapping the two ends. Duct tape in place.



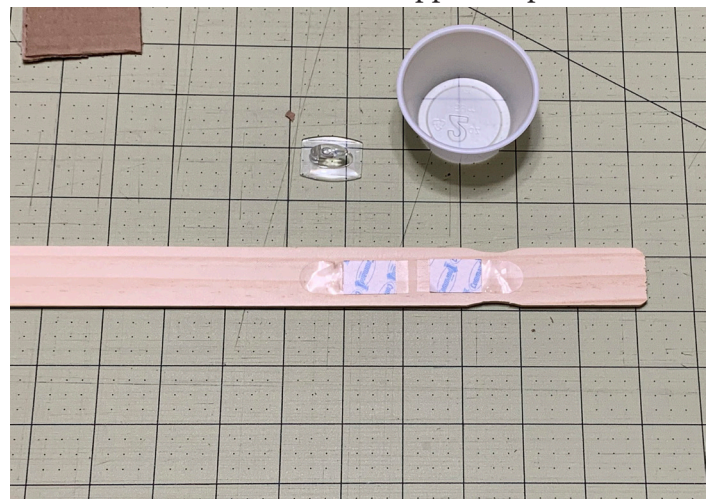
One end tab cut off

10) End view of cross-support. Cut off one of the overlapping end tabs.

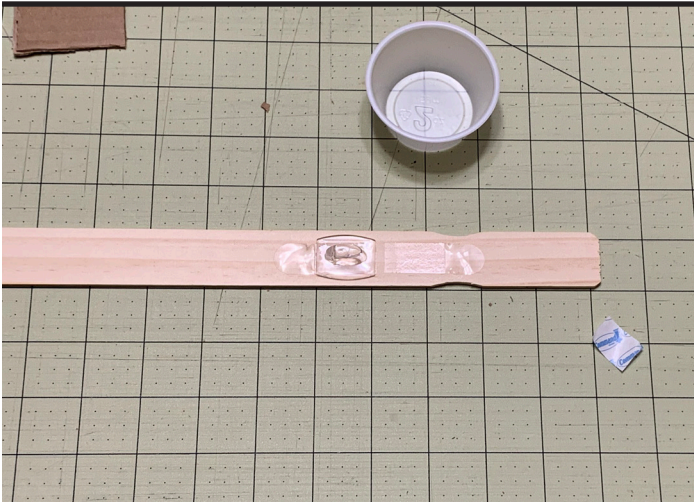


Punch one hole on each tab, fold end over, mark location for 2nd hold and punch it (for pencil).

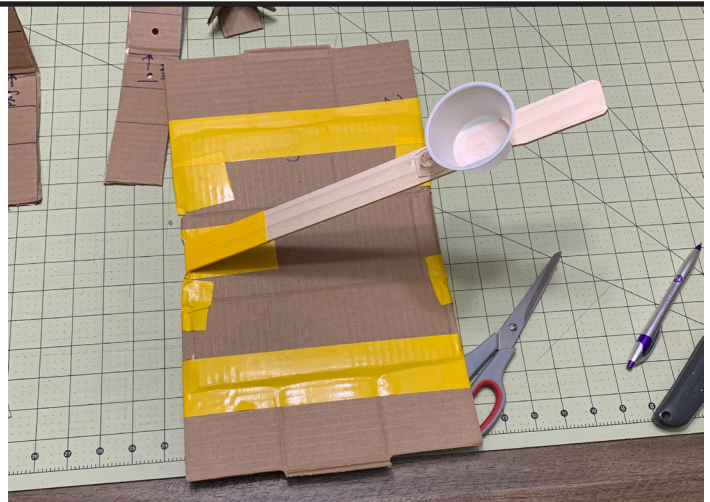
11) Clip ends to fold. We'll tape these flaps to the frame to secure the cross-support in place.



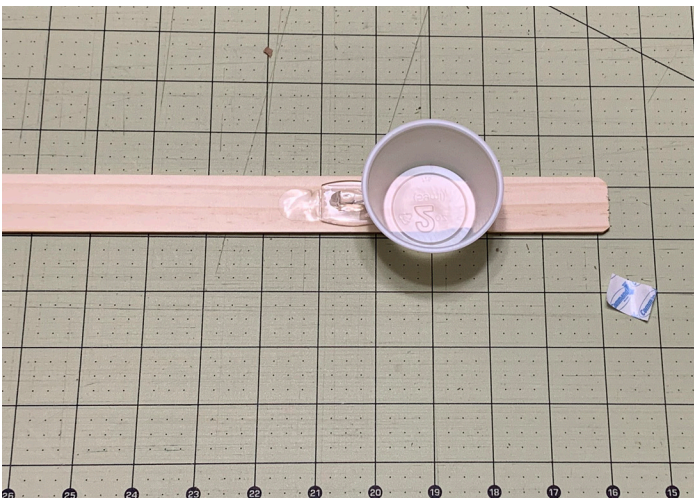
12) Attach two adhesive tabs to paint stir-stick as shown. Press down to secure to stick.



13) Attach plastic hook, open side towards end.



16) Stir-stick taped in place.



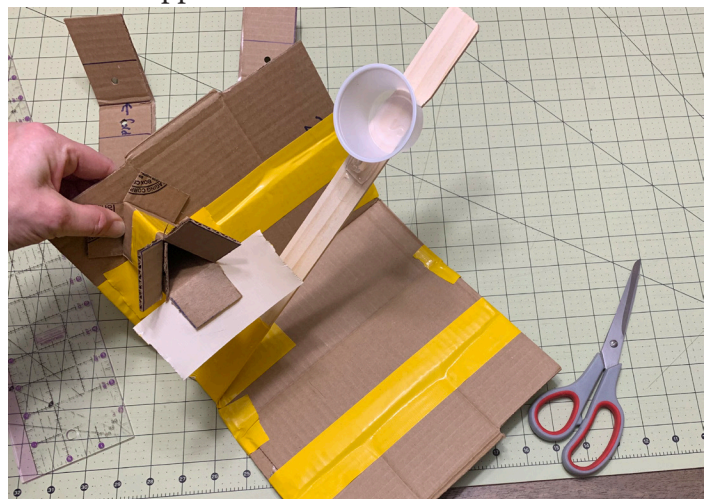
14) Attach condiment cup just above plastic hook.
Leave ~2 inches at end as tab to push down lever.



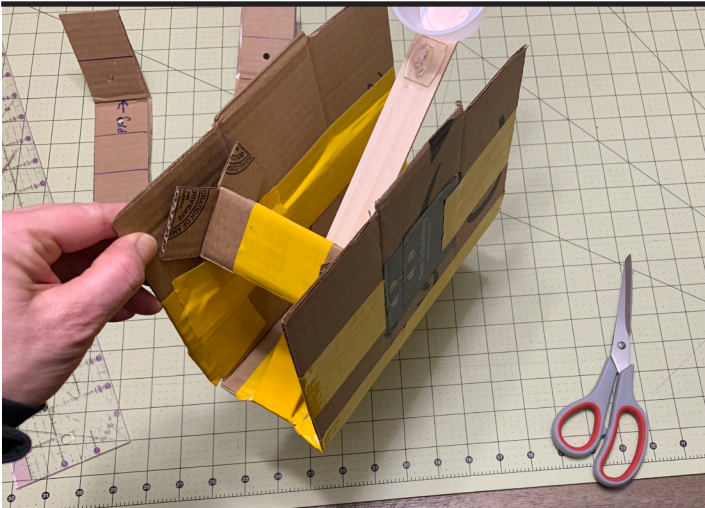
17) Cut two pieces of duct tape to attach to two tabs of cross-support as shown.



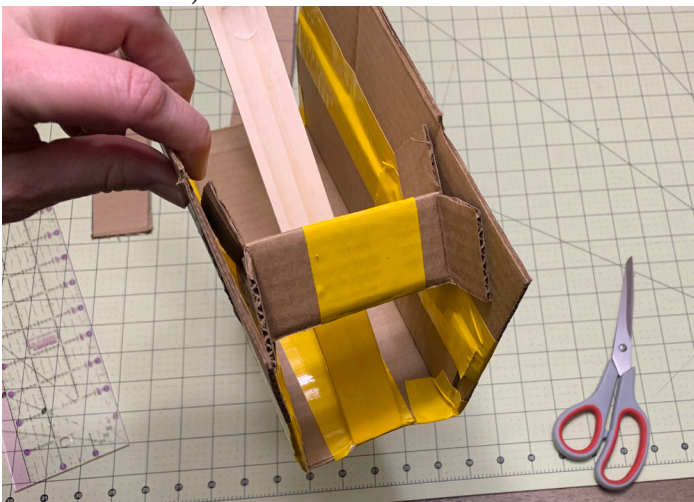
15) Attach stir-stick to bottom center with duct tape, such that cup faces up when stick is folded back.



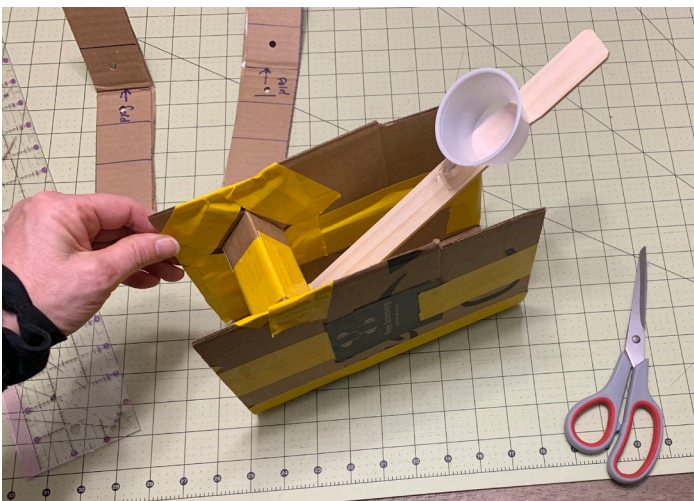
18) Attach bottom piece of duct taped cross-support to one side of catapult frame near top front edge.



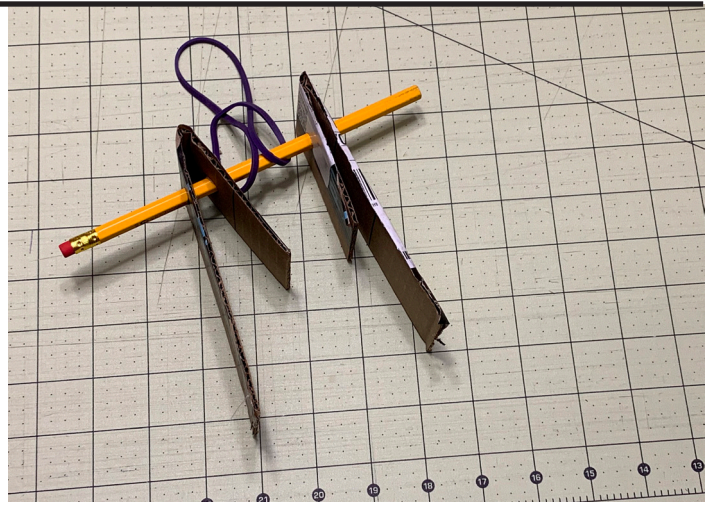
19) Attach second side of cross support (tape on bottom tab)



20) Another view of cross-support in place.



21) Tape top tabs of cross-supports down on each side.



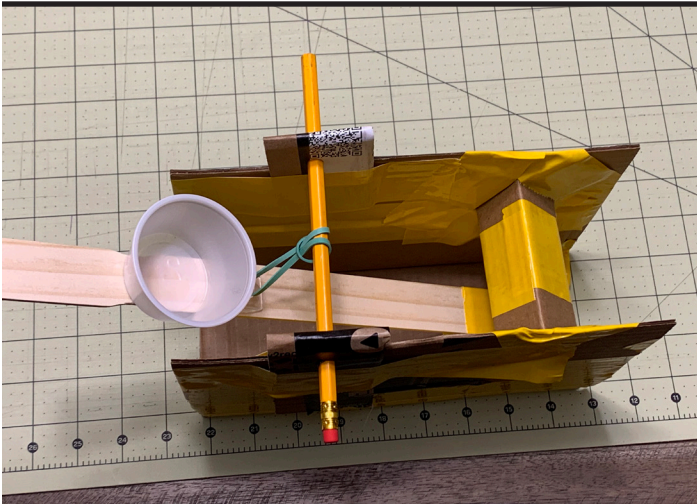
22) Feed pencil through holes in pencil support tabs



23) Shift pencil and tab supports as shown close to cup.



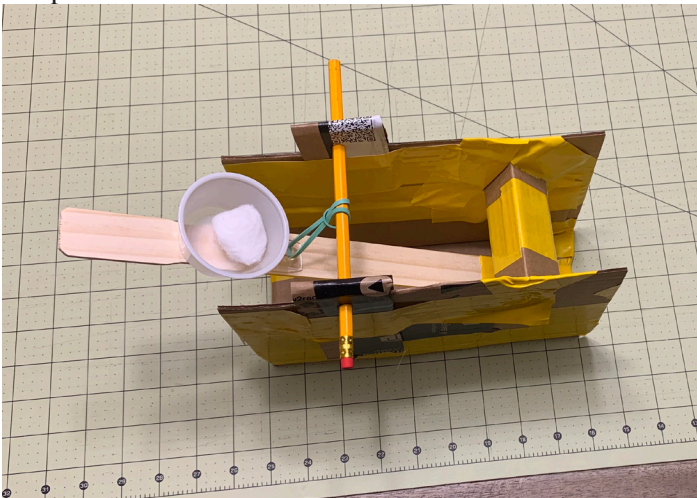
24) After checking placement of pencil and tab supports, tape tab supports in place.



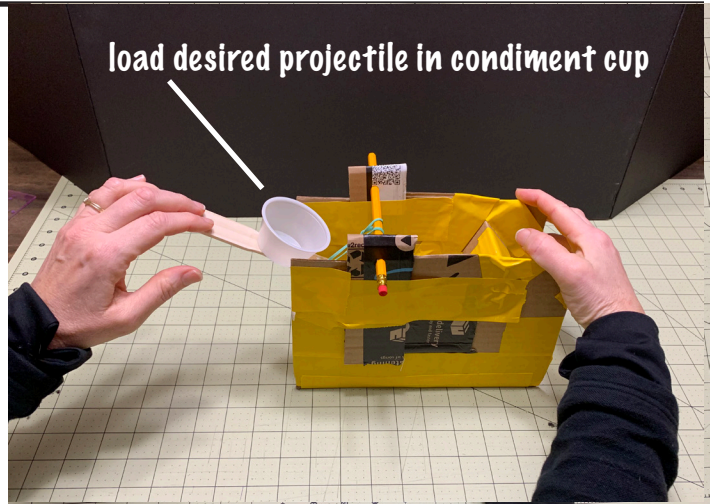
25) Hold rubberband on left side of pencil, let bottom loop fall below pencil, and feed under top loop.



26) Hook top loop of rubberband onto plastic hook of paint stir-stick.



27) Cardboard catapult, loaded (with a cotton ball) and ready to launch.



28) To launch, hold front of catapult with one hand, pull down on lever arm with other hand.



29) When the lever arm is flush with the ground, you're ready to launch (just release lever arm).



30) Try out a variety of projectiles, and record their weights. Use silly putty to test different sizes.



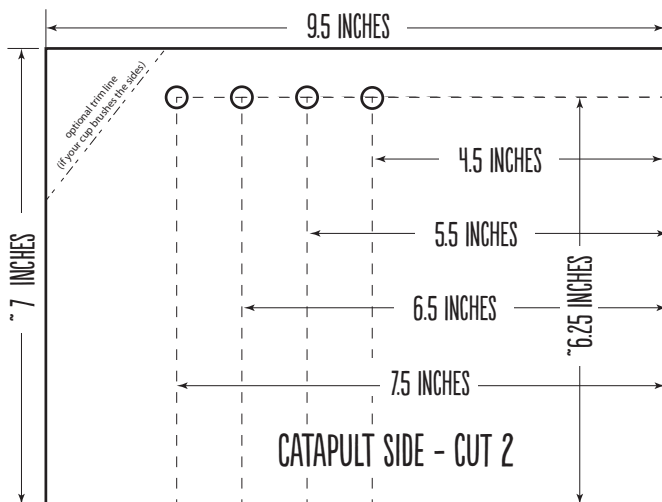
There isn't just one way to make a cardboard catapult.

If you have a **larger box or larger piece of cardboard**, you can simply **cut out the sides** and tape or duct-tape the pieces together. You may find that a lot easier than my original instructions.

Full size templates are provided on the next two pages. This design also allows for **multiple pencil placements...** so you can check the effect of the lever arm angle on distance. Maybe you can find an **optimum** setting!

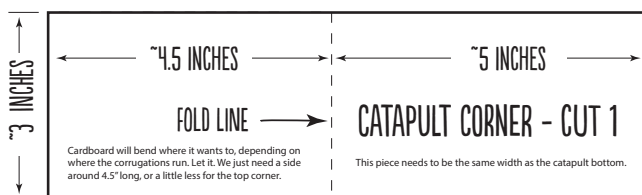
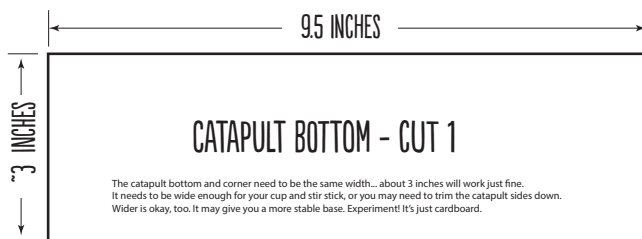
The photo at bottom shows a catapult I made from an **IKEA magazine holder...** the possibilities are endless, but these schematics should give you an idea of where to start. *This one was hard to cut pencil holes for... I had to use a knife to cut an 'X' in the sides, then work the pencil in.*

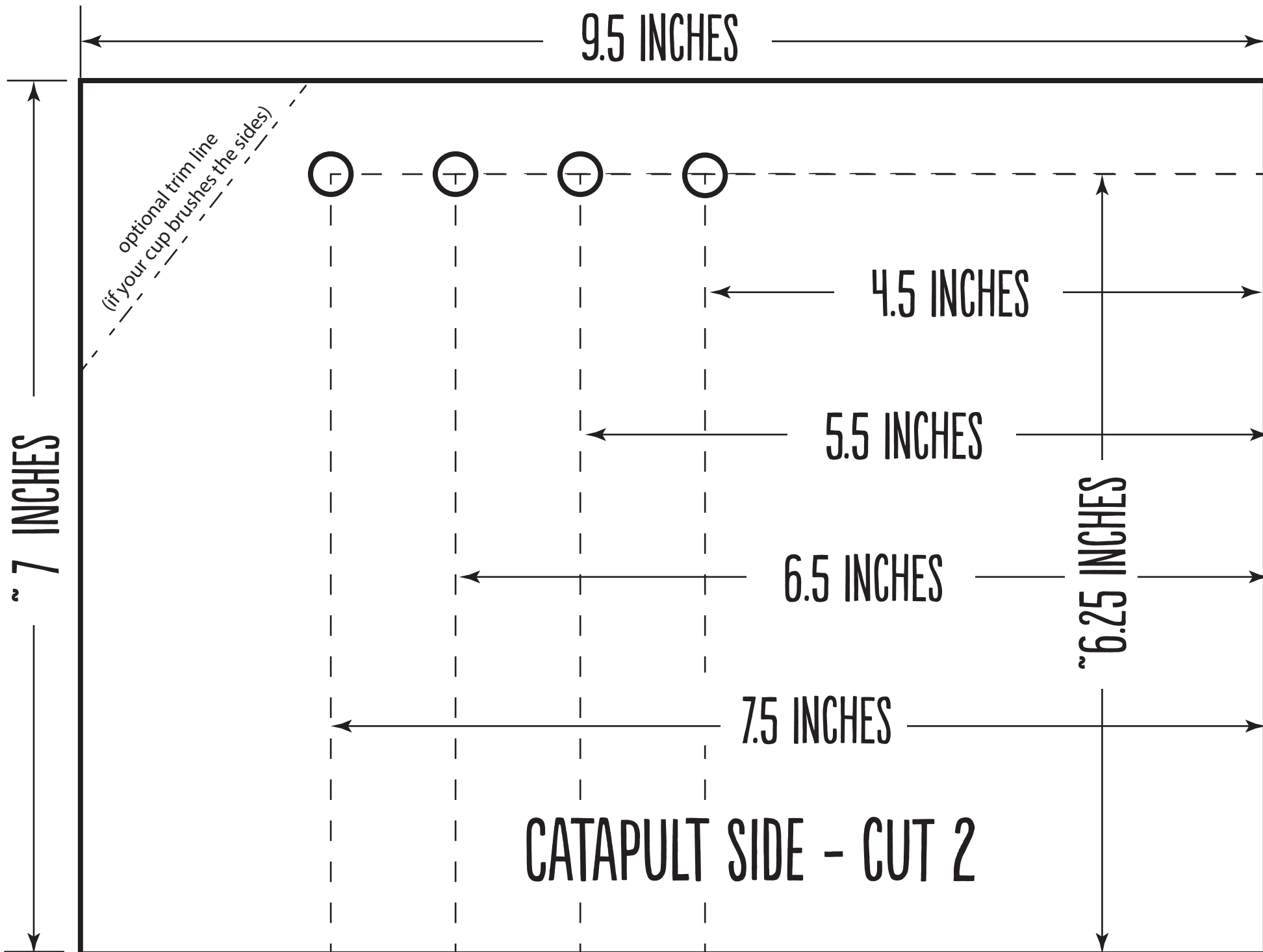
Good luck! Have fun!



Above, left - front view of alternate 'A' showing corner.

Above, right - inside view of alternate 'B' showing duct tape attachment of stir stick. Below-side view of alternate 'B'.





9.5 INCHES

~3 INCHES

CATAPULT BOTTOM - CUT 1

The catapult bottom and corner need to be the same width... about 3 inches will work just fine. It needs to be wide enough for your cup and stir stick, or you may need to trim the catapult sides down. Wider is okay, too. It may give you a more stable base. Experiment! It's just cardboard.

~3 INCHES

~4.5 INCHES

~5 INCHES

FOLD LINE

CATAPULT CORNER - CUT 1

Cardboard will bend where it wants to, depending on where the corrugations run. Let it. We just need a side around 4.5" long, or a little less for the top corner.

This piece needs to be the same width as the catapult bottom.