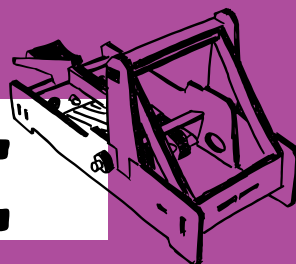


# ACTIVITY 1

Get ready to build! In this activity, you'll assemble the catapult that you'll use throughout the next two activities. As you build, think about how much work it must have been to build a catapult big enough to knock down city walls!



## LET'S MAKE

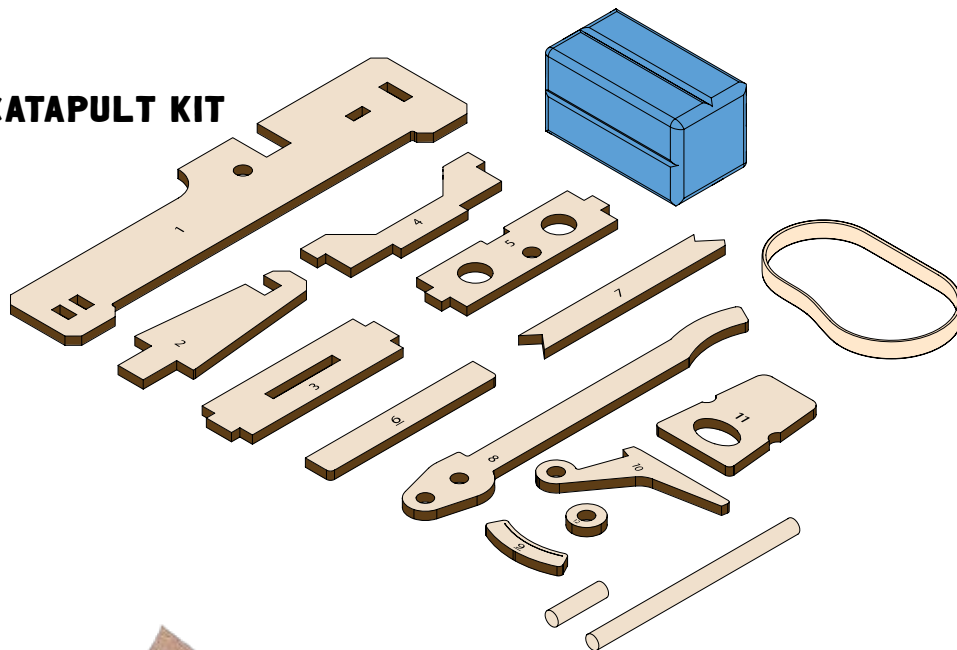
## GATHER YOUR SUPPLIES

### INCLUDED



**SAFETY GLASSES**

### CATAPULT KIT



### NOT INCLUDED



**WHITE GLUE**



**SANDPAPER OR NAIL FILE**



**Note:** Some of these pieces will fit very snugly. Instead of forcing the piece in, which might cause the wood to snap, try wiggling the piece into its place. If it still does not fit, try sanding it down with sandpaper or a nail file.

## MAKE THE BASE



### STEP 1

Punch out the two Part 1s, two Part 2s, and two Part 11s.



### STEP 2

Apply glue on the bottom edges of one of the Part 2s. Place the glued bottom into the notch on top of a Part 1. Repeat for the second Parts 1 and 2. Be sure the notch on Part 2 is facing the longer portion of Part 1 as shown.



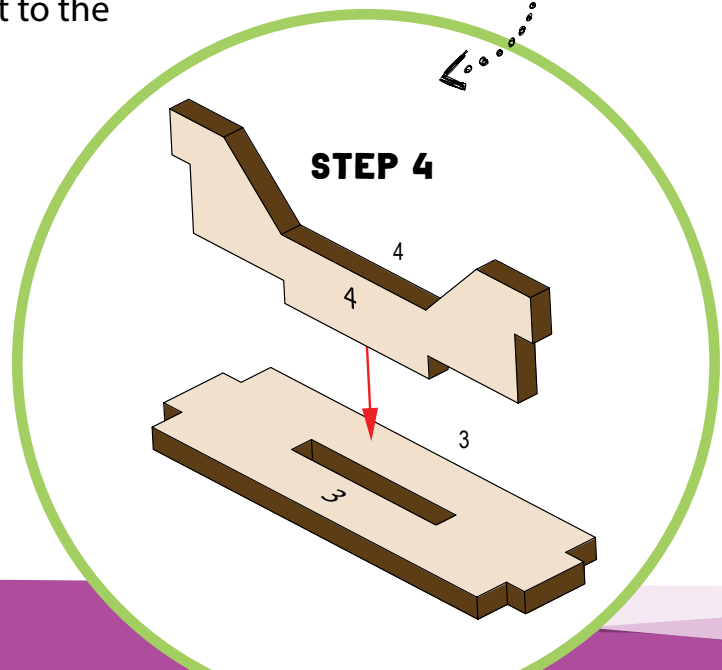
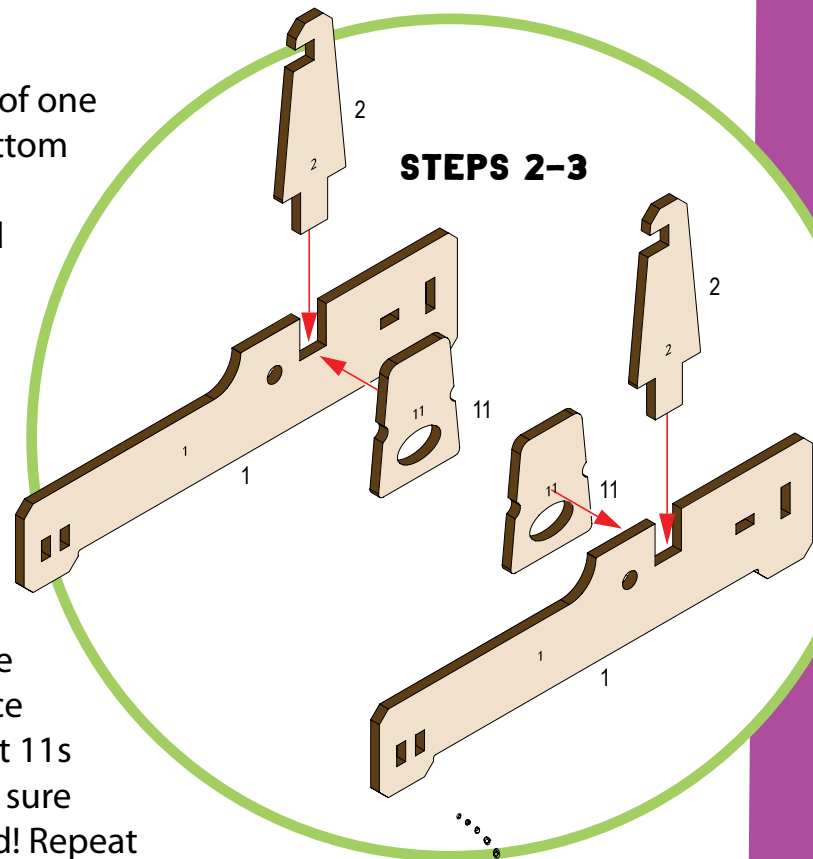
### STEP 3

Part 11 will cover Part 1 and 2 where they are glued together. The semicircle on the Part 11 will align to the circle on Part 1 and be on the inside of the Catapult. Place glue on the face of one of the Part 11s and glue it to Parts 1 and 2. Make sure the circle on Part 1 is NOT covered! Repeat for the other Part 11 applying it to the other Parts 1 and 2.

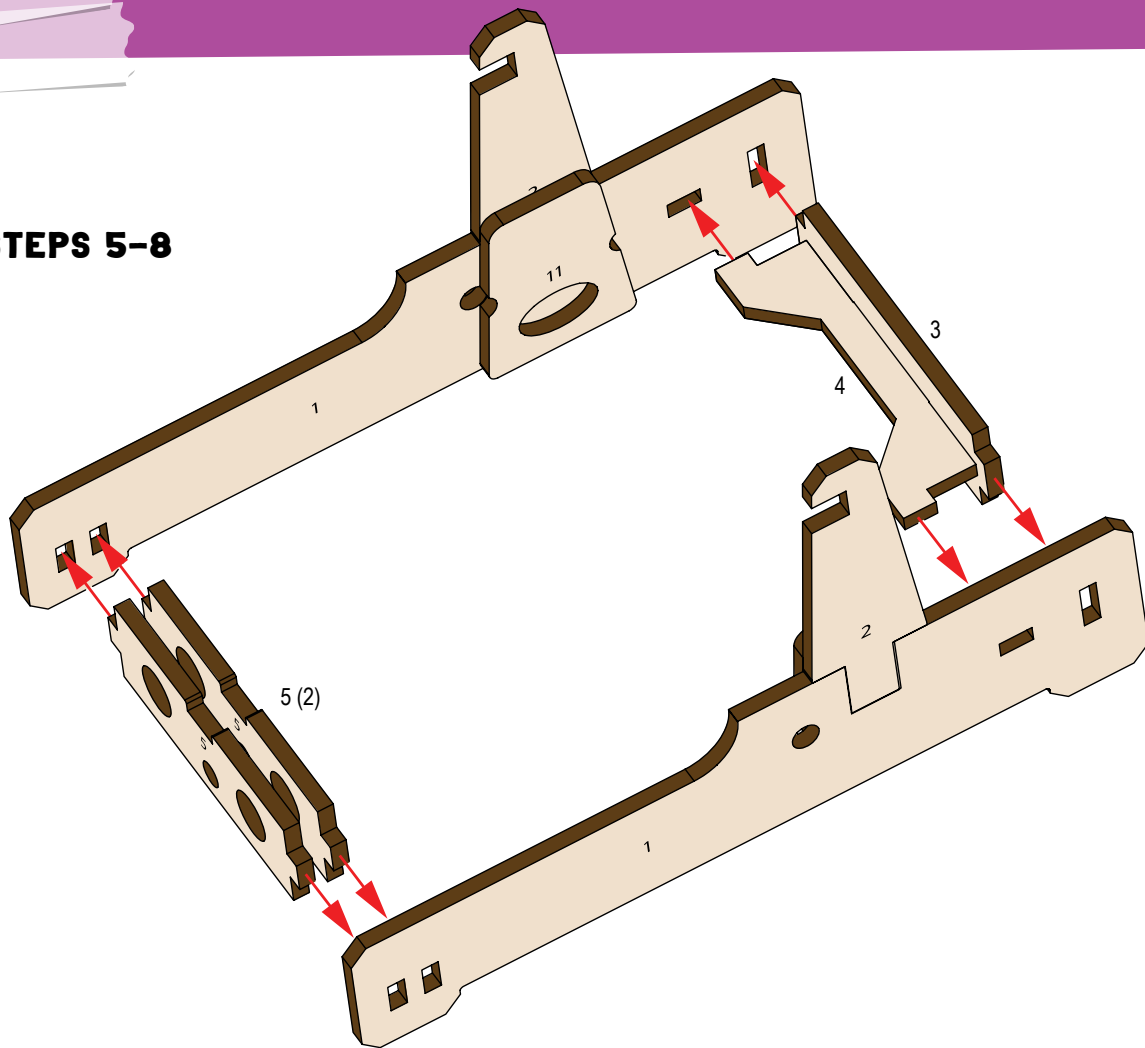


### STEP 4

Punch out Parts 3 and 4. Apply glue to the bottom edge of Part 4; insert glued edge into the slot on Part 3.



## STEPS 5-8



### STEP 5

Glue the notch on one side of Part 3 and 4 into the slots at the back (the wider end) of one of the Part 1s as shown.

### STEP 6

Punch out the two Part 5s. Hold them together and align both holes. If they don't align, turn one of the parts around.

### STEP 7

Apply glue to the notches on one end of the Part 5s. Place the notches into the slots at the narrow end of Part 1 (the same Part 1 that has Parts 3 and 4 glued to it). Be sure the holes in Parts 5 still align like you completed in Step 6.

### STEP 8

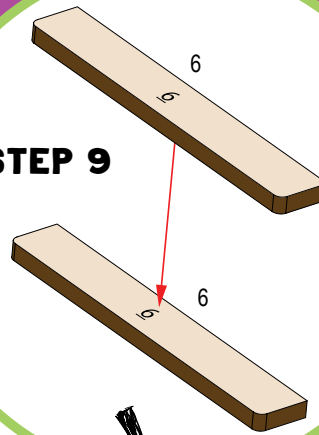
Apply glue to the notches on the other side of the Part 5s, Part 3, and Part 4. Place the other Part 1 on top and wiggle the notches into their corresponding slots on Part 1.



## STEP 9

Punch out the two Part 6s. On each piece, two of the corners are curved and two are right angles. Stack the parts so that the curved corners are on top of each other. Glue these two parts together.

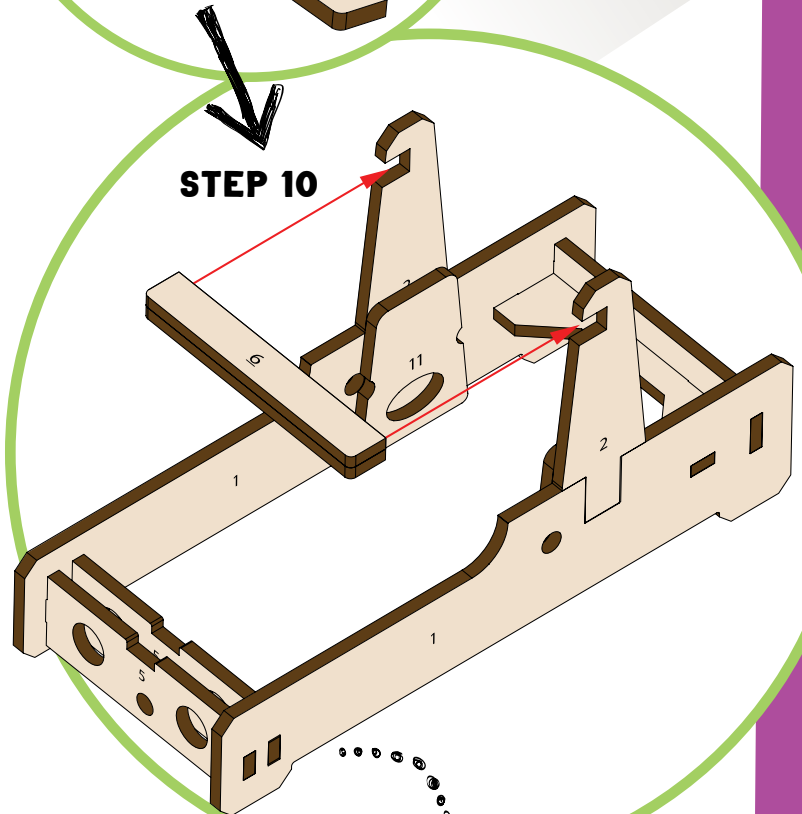
## STEP 9



## STEP 10

## STEP 10

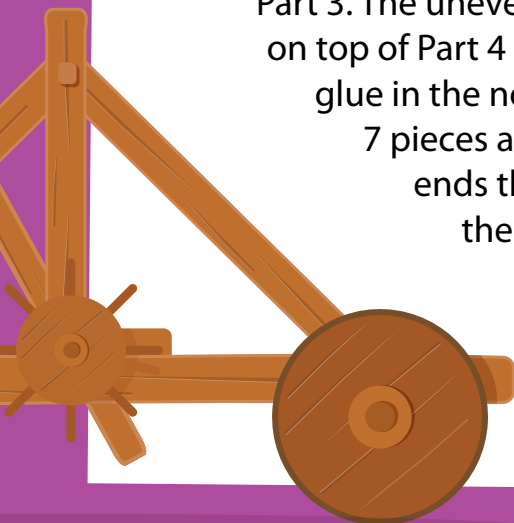
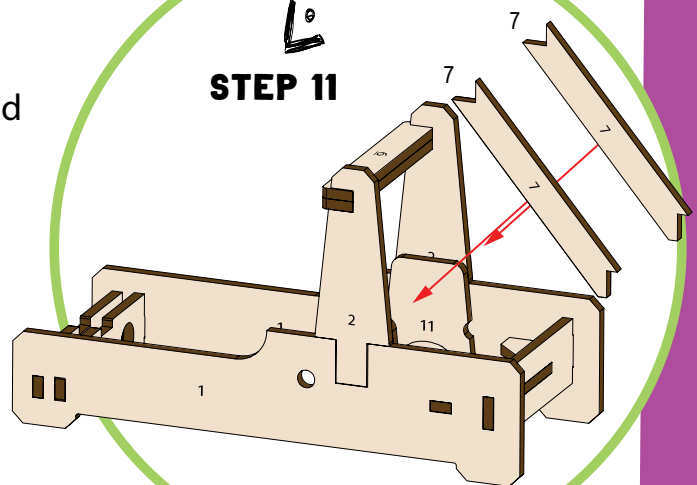
Apply glue to the inside of both notches at the top of the Part 2 pieces. Insert the Part 6 pieces into these notches so the side with the curved corners is facing out.



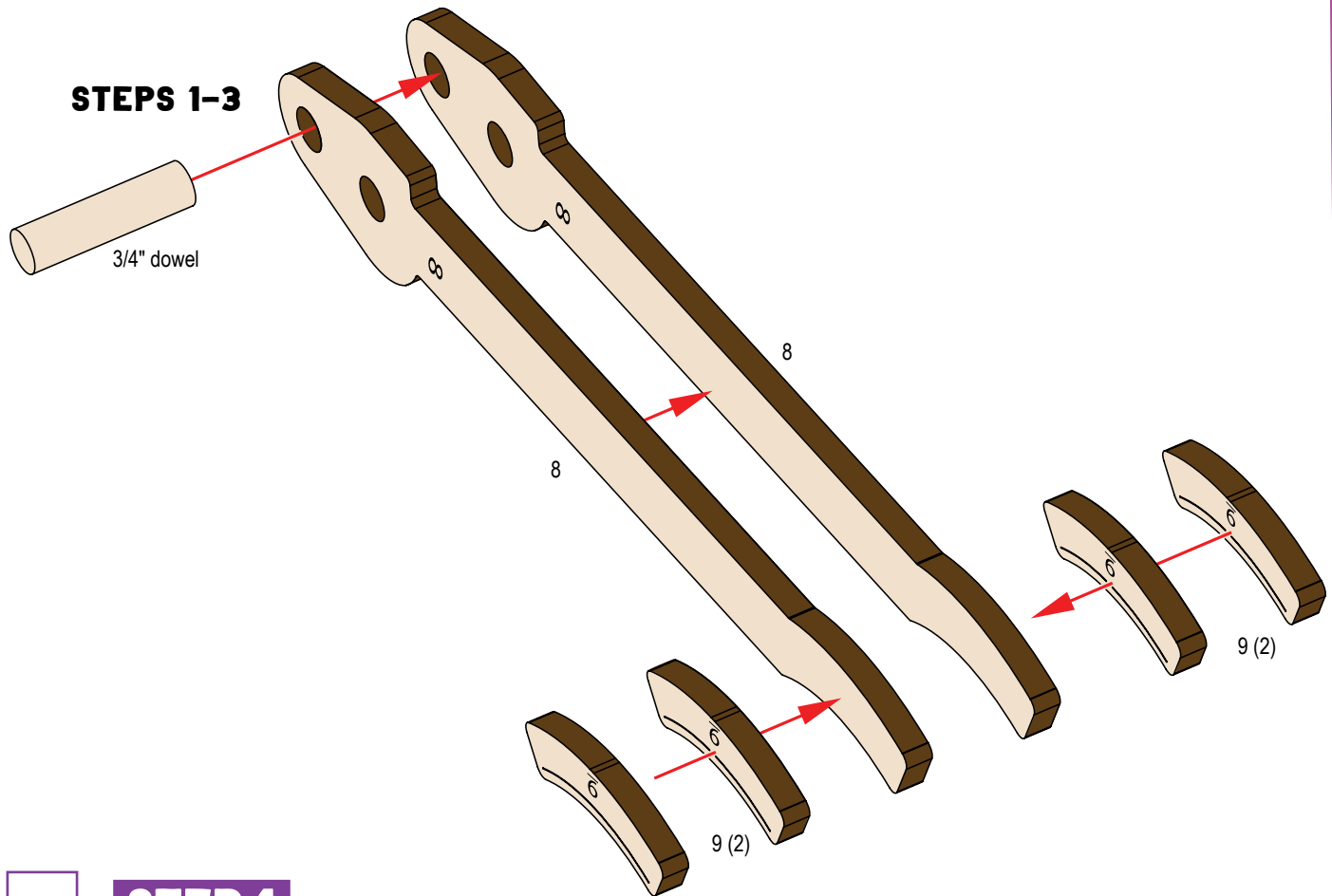
## STEP 11

Punch out the two Part 7s. These will be glued at an angle between the Part 6s and Part 3. The uneven notched end will rest on top of Part 4 and inside Part 3. Apply glue in the notched ends of the Part 7 pieces and a little on the face ends that will be against the inside of the catapult (Parts 1 and 2). Place the Part 7 pieces into place as shown.

## STEP 11



# CONSTRUCT THE ARM AND TRIGGER



## STEP 1

Punch out the Part 8s and glue them together stacked one on top of the other. This will be the catapult arm.

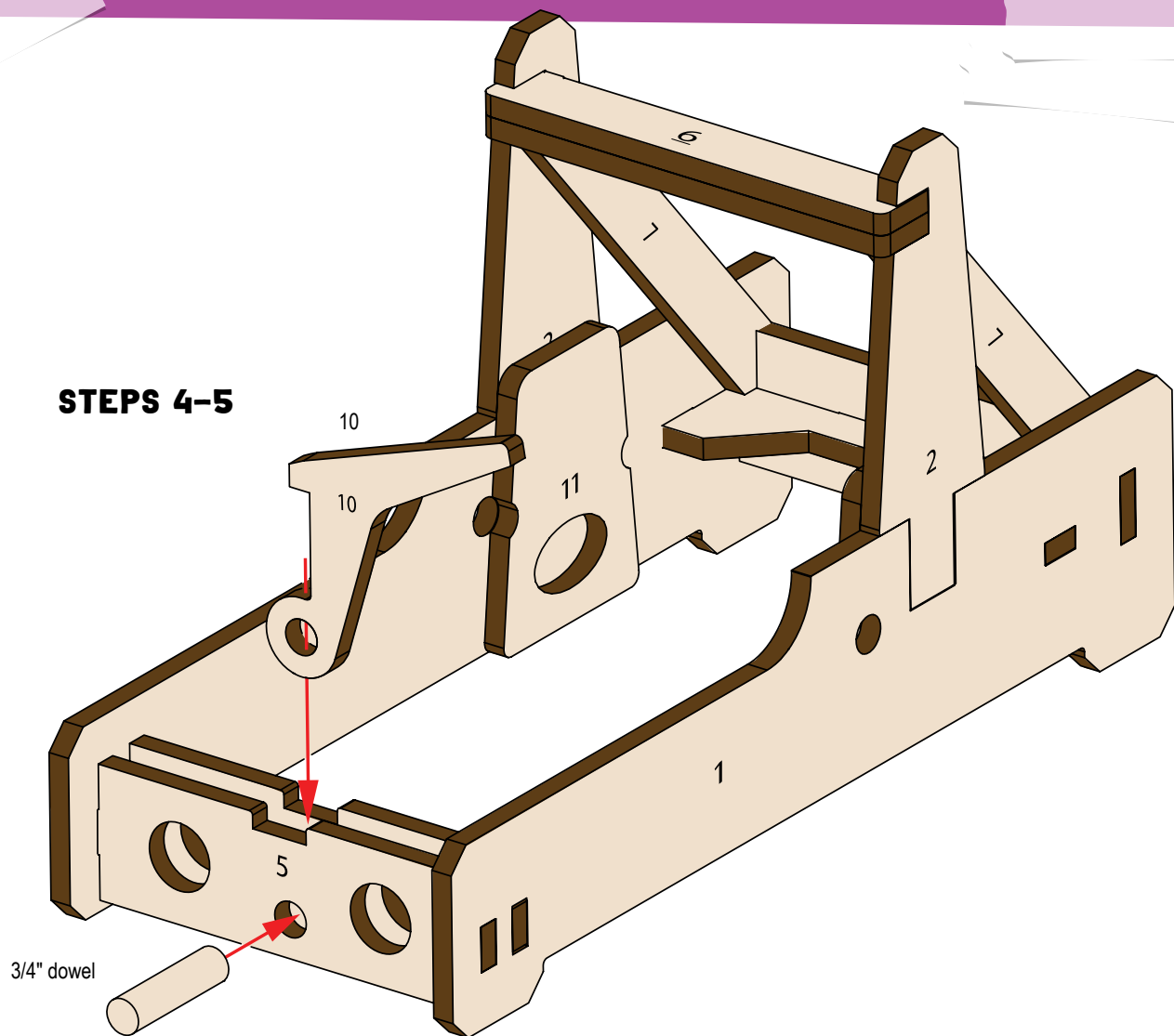
## STEP 2

Punch out the four Part 9s. Glue two of them to one side of the curved end of the arm (Part 8). Make sure the curve of the Part 9s aligns with the curve in the arm. Hold together for a minute until they will stay in place. Glue the other two Part 9s on the other side of the arm.

## STEP 3

When the arm is dry, push a 3/4" dowel through the hole at the far end of the arm. Center the dowel in the middle of the arm. Place glue around the dowel where it meets the arm. This will prevent the dowel from sliding around when used.

## STEPS 4-5



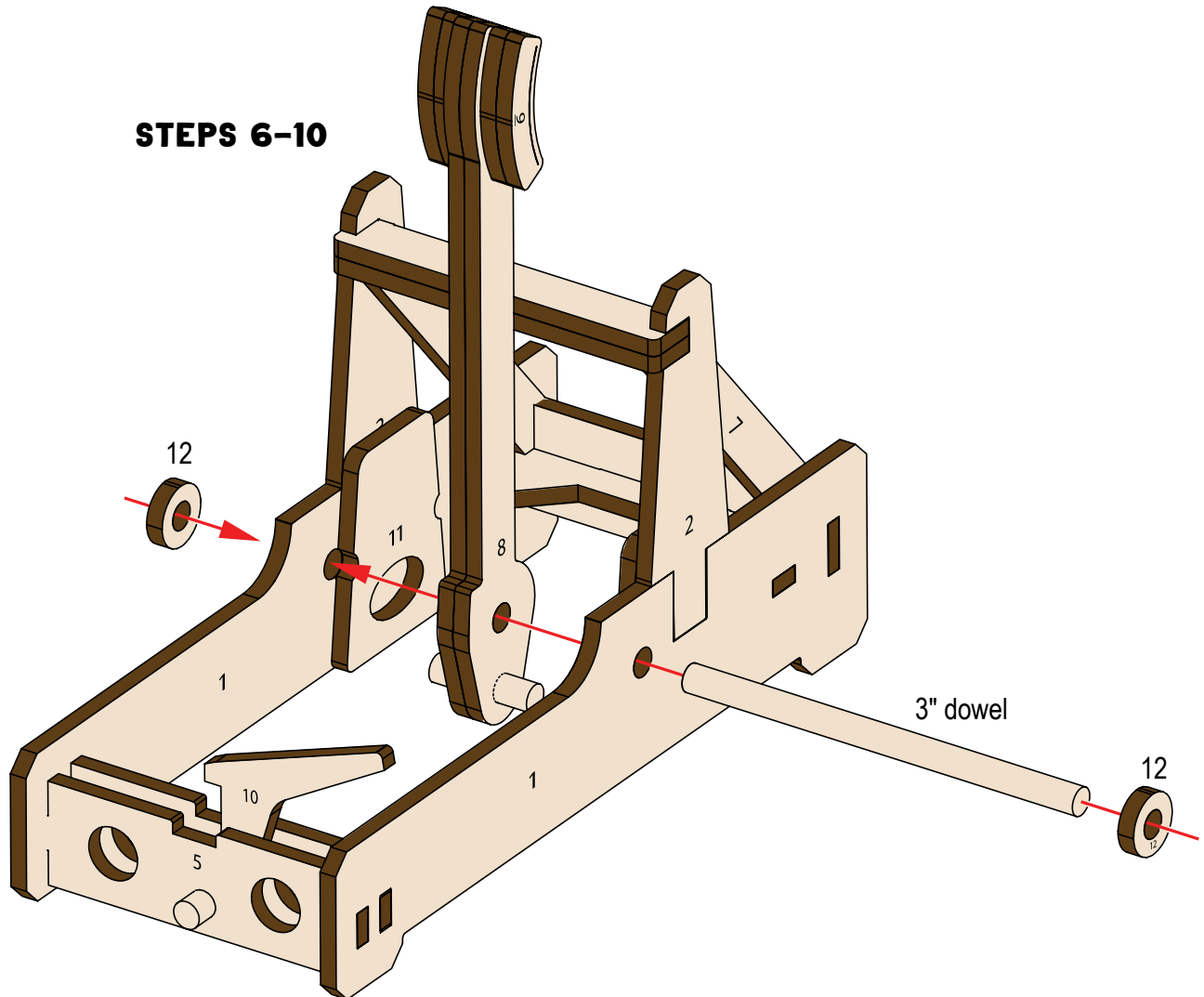
### STEP 4

Punch out Part 10. This will be the trigger on your catapult. Put the catapult base so the two circles from Part 5 are closest to you. Part 10 will go in between the two Part 5s. The hole of Part 10 is on the bottom, and the long arm should be pointing to the right as shown.

### STEP 5

Push the bottom of Part 10 in between the two Part 5s and align the holes. Push a 3/4" dowel through all three holes, leaving 3/8" extending from the outside of Part 5 (the side closest to you). Apply glue on the dowel where it intersects with the Part 5s. Make sure you don't get any glue on Part 10 (you'll need the trigger to move!).

## STEPS 6-10



### STEP 6

Insert the three-inch dowel through the hole in one side of the catapult (near the middle of Part 1) and thread the dowel through the remaining hole in the catapult arm and then out the other side of the catapult.

### STEP 7

Make sure an even amount of dowel is extending from either side and that the arm is centered in the dowel (when lying down, the arm should fit into the notches at the top of the Part 5s).

### STEP 8

Dab glue around the dowel where it intersects with the arm. This will keep the arm from moving around on the dowel.



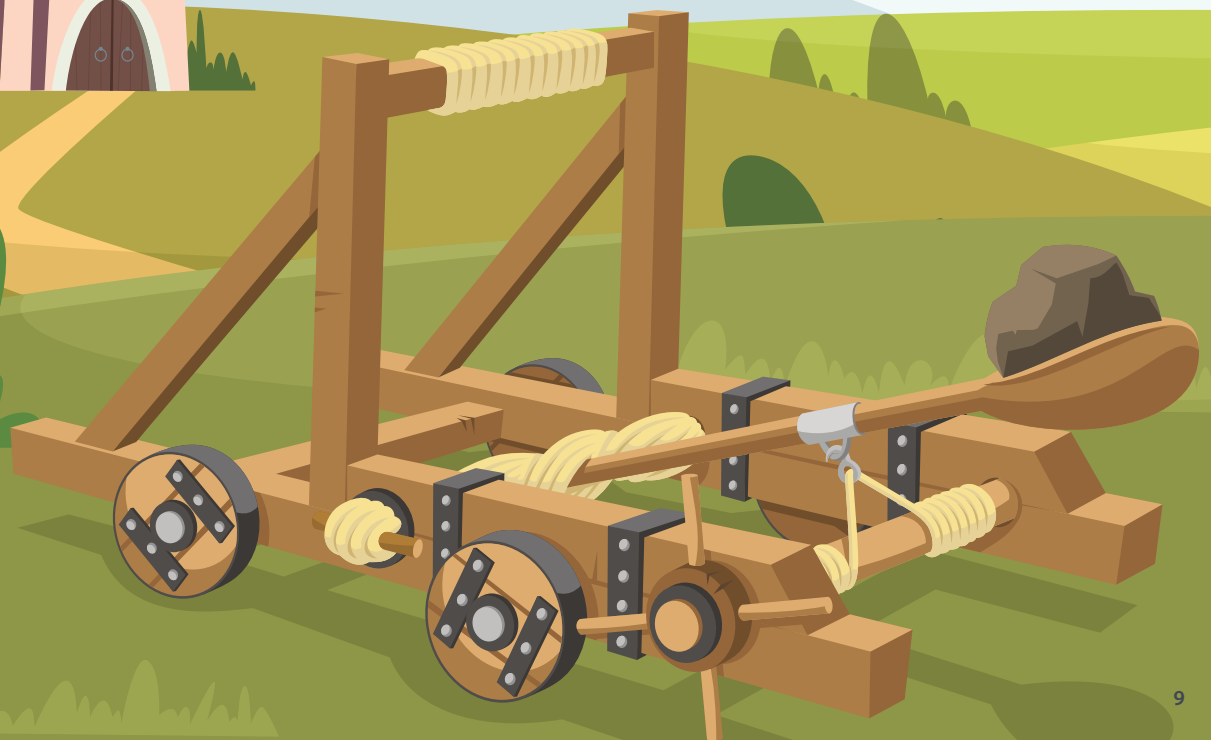
## STEP 9

Punch out the two Part 12s. Slide one on each end of the three-inch dowel. Apply a dab of glue on the outside of the Part 12s. Make sure you do NOT get any glue between the arm and the catapult base. You want to make sure the dowel will move freely in the hole.



## STEP 10

Allow the catapult to completely dry.

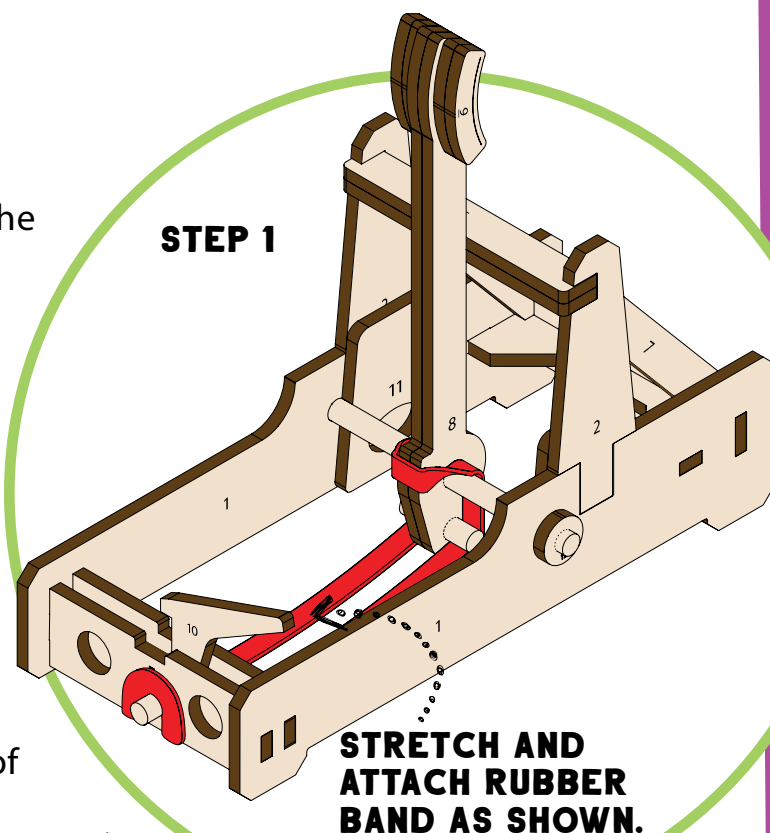


## FINISHING TOUCHES

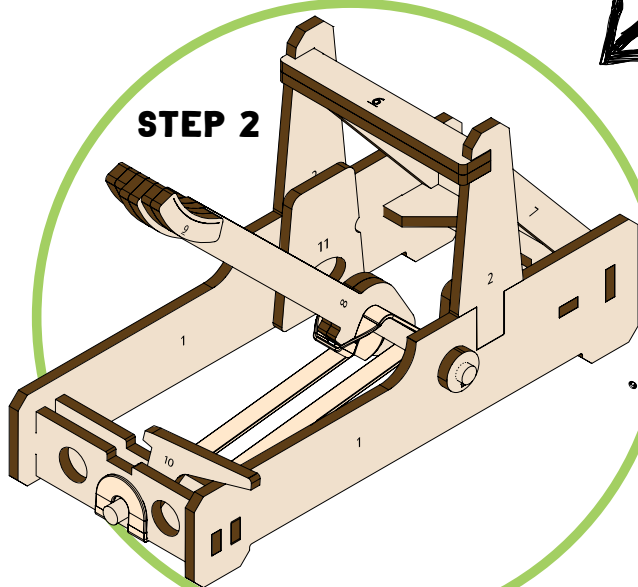
### STEP 1

Place the rubber band around the arm as shown. Pull the rubber band toward the front of the catapult. Bring the rubber band toward the back of the catapult and make sure it catches on the dowels protruding from either side of the bottom of the arm. Pull the band under the back of the catapult (under the Part 5s) and hook it onto the dowel sticking out of the back of the Part 5s.

### STEP 1



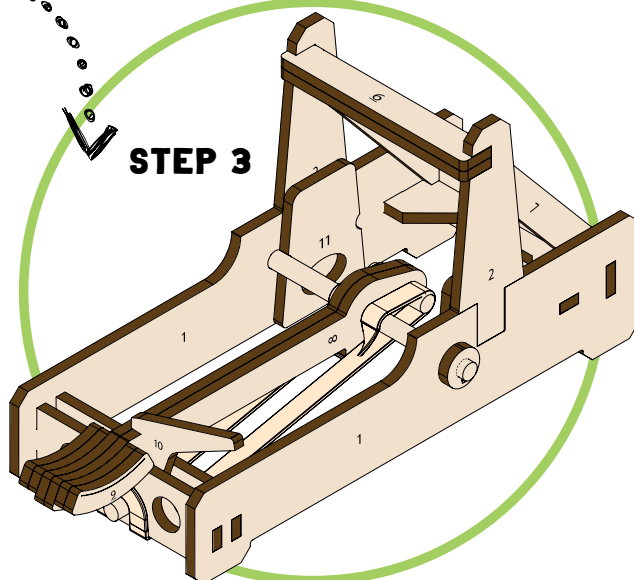
### STEP 2



### STEP 2

Pull the catapult arm down and move the trigger over it to hold it in place.

### STEP 3



### STEP 3

To fire the catapult, push the trigger arm down.




## **SAFETY**

- Anyone operating the catapult or nearby during operation should wear safety glasses.
- Never use a sharp object as a projectile. Never fire at a living thing.
- Use this device only in the manner discussed and illustrated within this guide. Misuse of this product can cause serious injury.
- Make sure the launch site and flight path are clear of all people prior to launch.



## **THINK ABOUT IT**



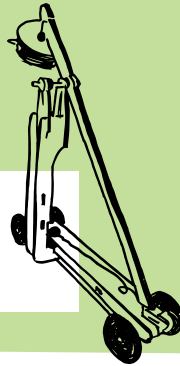
Today, scientists use math to calculate the launch angle and other variables in order to reach a target. How do you think soldiers in the Middle Ages figured out how to reach their target?

There are a few different types of catapults including onager, mangonel, trebuchet, and ballista. Research the difference between each of these. Which type is the one you have built in this activity?

# ACTIVITY 1

Let's build a trebuchet! As you build, think about how the trebuchet works. Can you also identify the different forms of energy that it utilizes?

## LET'S MAKE



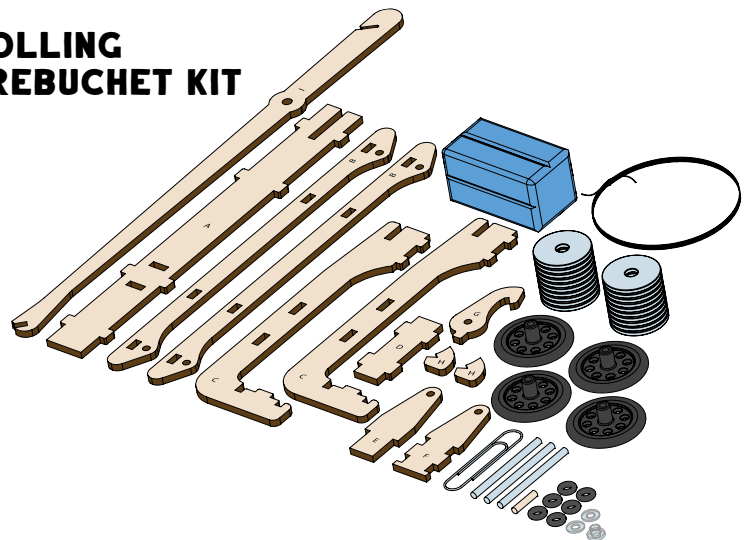
## GATHER YOUR SUPPLIES

### INCLUDED



**SAFETY GLASSES**

### ROLLING TREBUCHET KIT



### NOT INCLUDED



**WHITE GLUE**



**NEEDLE-NOSE PLIERS**



**SCISSORS**



**SANDPAPER OR NAIL FILE**



**KITCHEN SCALE (OPTIONAL)**

**Note:** Some of these pieces will fit very snugly. Instead of forcing the piece in, which might cause the wood to snap, try wiggling the piece into the slot.

## BUILDING THE PARTS



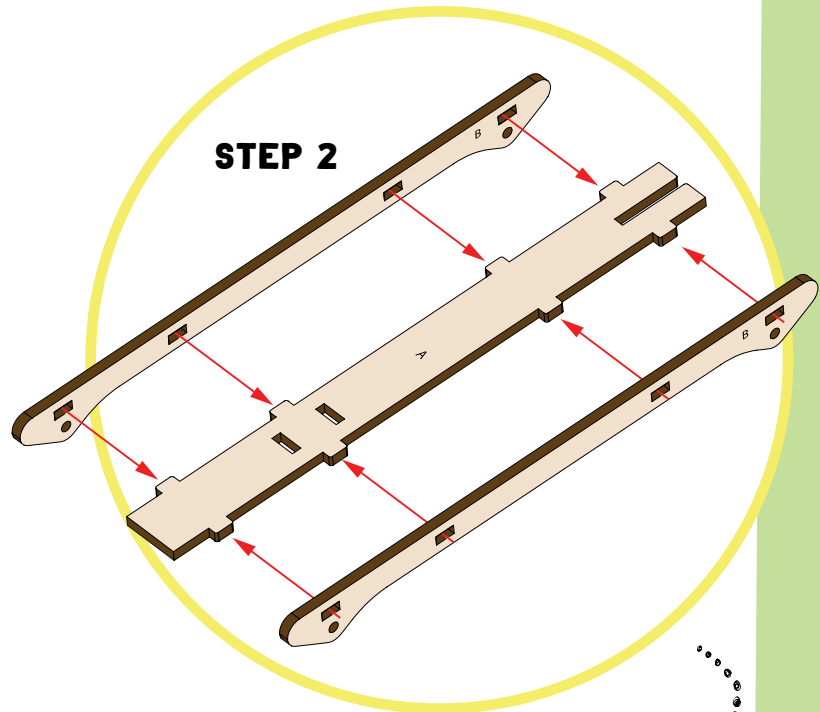
### STEP 1

Pop out all the parts from the wooden sheet. Don't throw any of the scraps away until your build is complete, just in case you missed a small part.



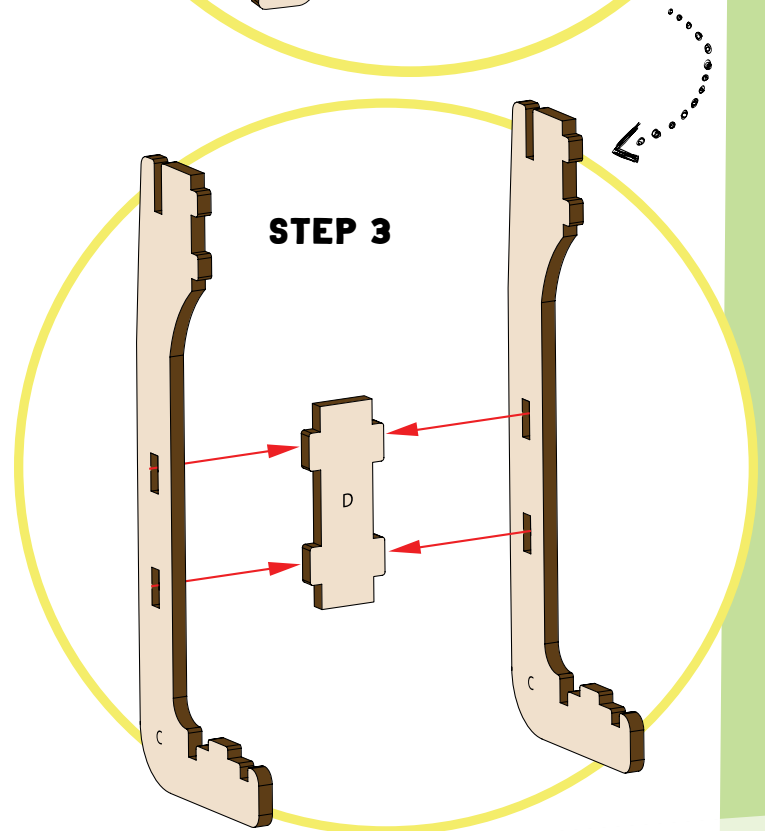
### STEP 2

Glue one Part B onto the side of Part A. Glue the second Part B on the other side of Part A. Set aside to dry. This will make the chassis.



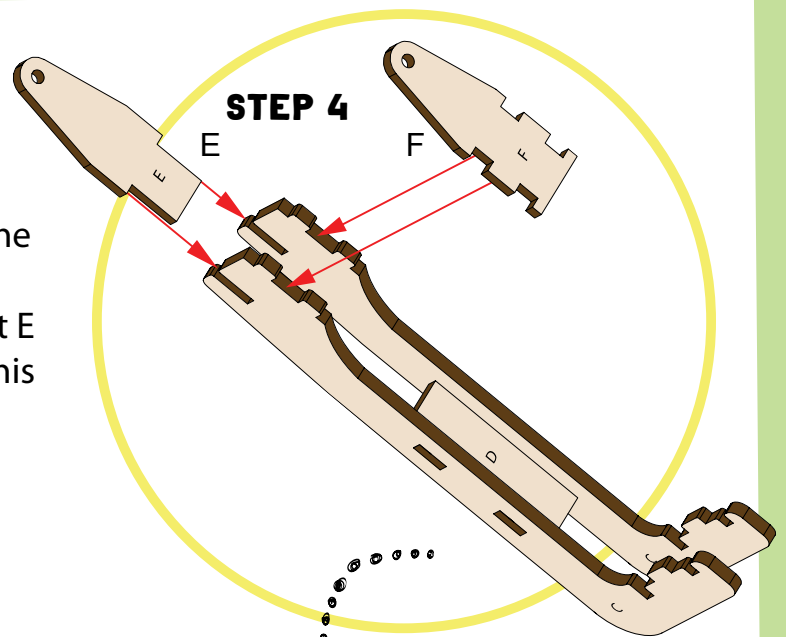
### STEP 3

Glue Part D in the two middle slots on one Part C. Glue the second Part C on the other side of Part D.



## STEP 4

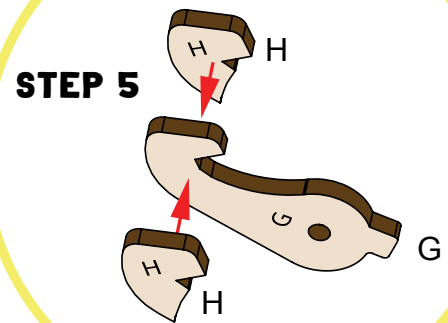
Glue Part F on top of the end of the joined Parts C where the slots fit together. Now, glue and slide Part E so it is parallel to Part F. Let dry. This will make the vertical assembly.



## STEP 5

Glue Part H on either side of Part G – do this so the parts line up on the **outside** of the curve (the inside of the curve will not be even). This will make the trigger assembly.

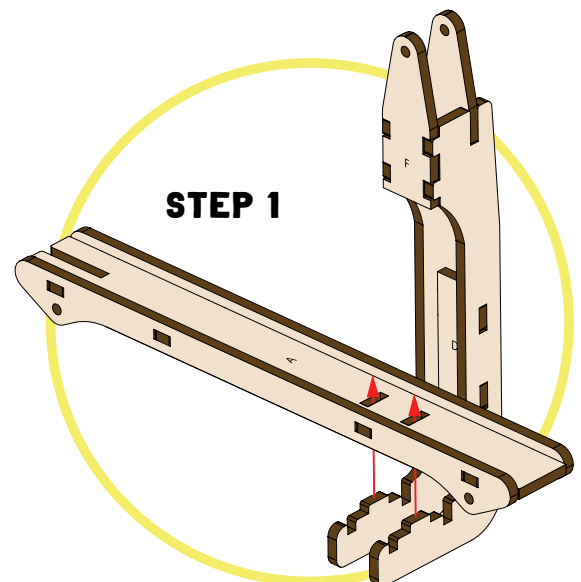
## STEP 5



# ASSEMBLING THE TREBUCHET

## STEP 1

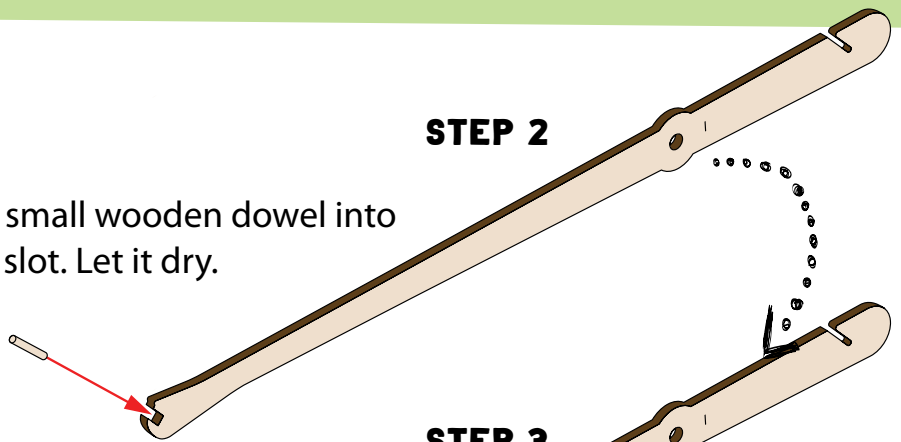
When all the parts are dry, glue the vertical assembly onto the chassis so the short, curved end is under the chassis.





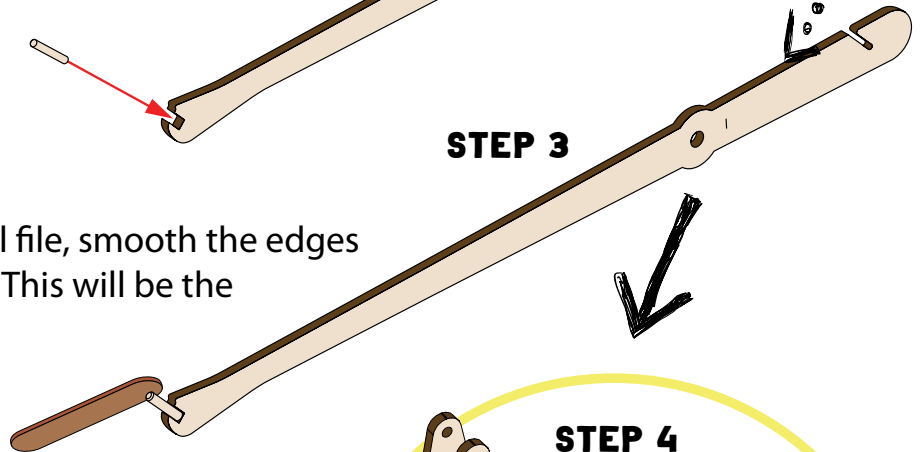
## STEP 2

Take Part I and glue the small wooden dowel into the end with an angled slot. Let it dry.



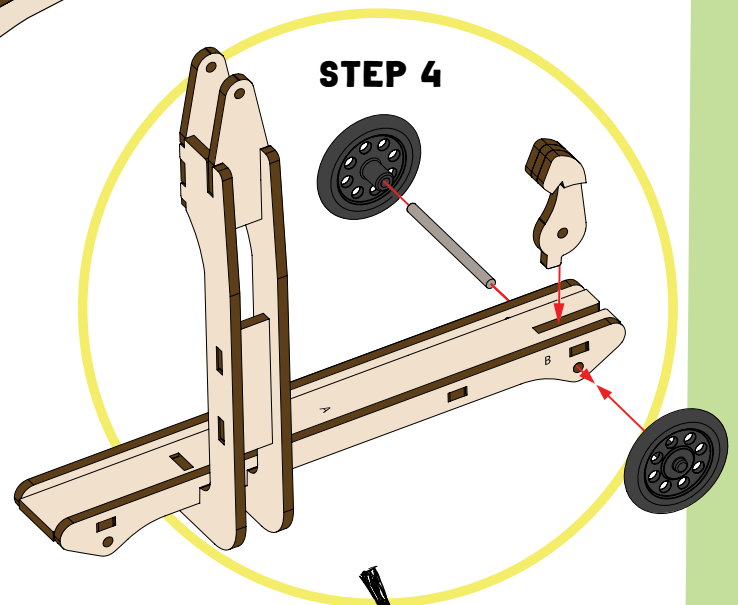
## STEP 3

With sandpaper or nail file, smooth the edges of the wooden dowel. This will be the throwing arm.



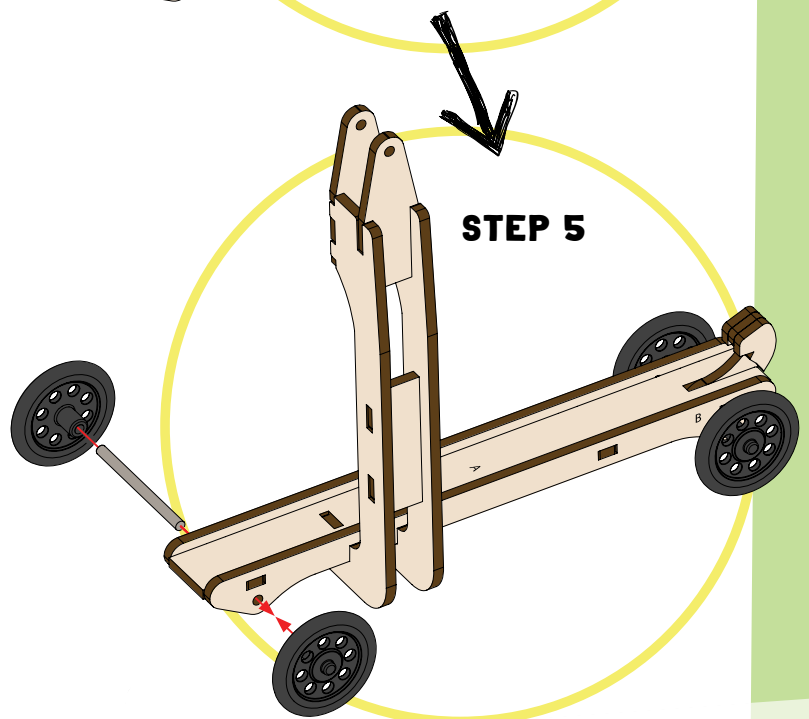
## STEP 4

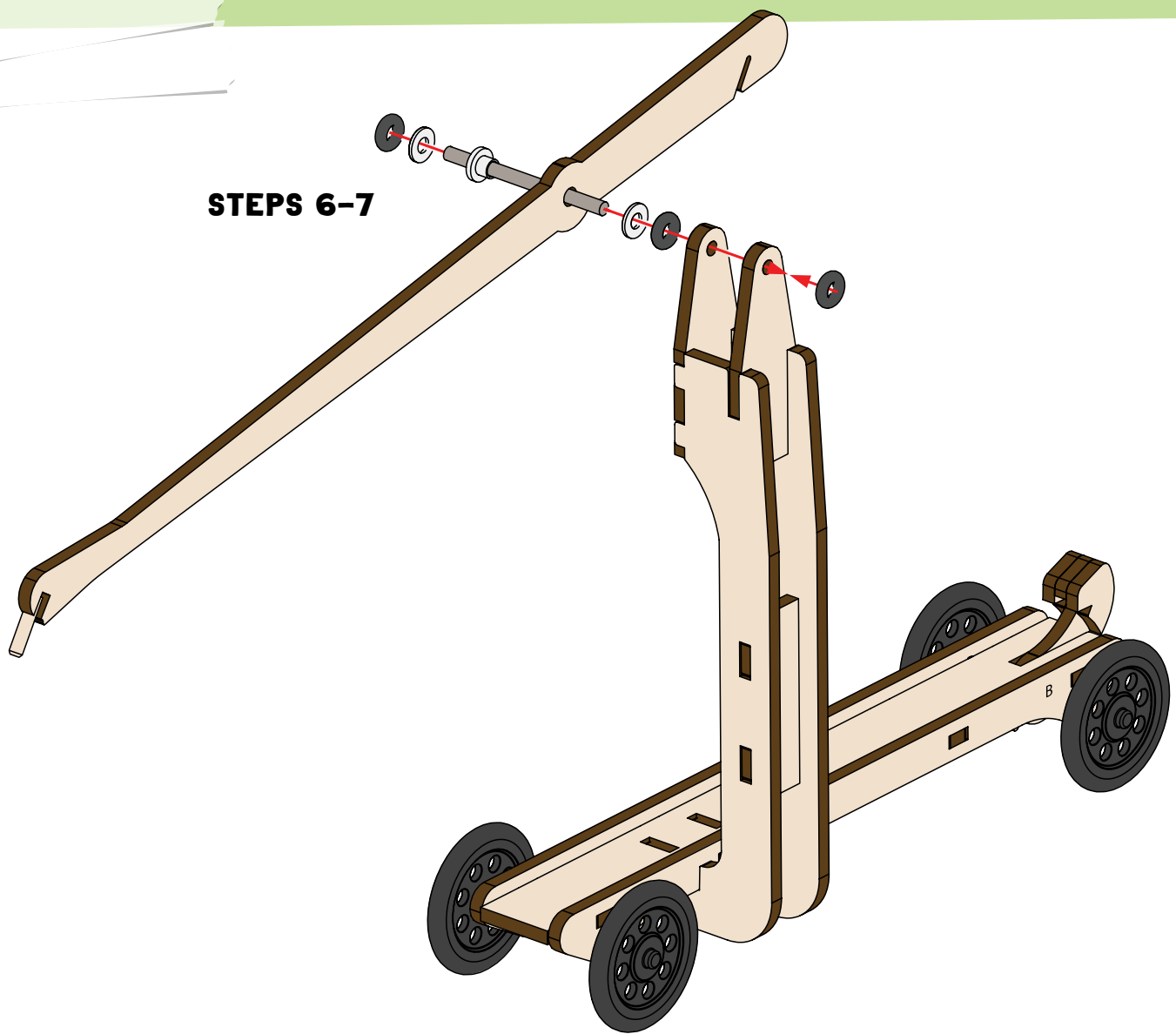
Insert one of the axles into a wheel and then insert into one axle hole on the front of the chassis (the end farthest from the vertical assembly). Thread the trigger onto the axle so the curved side faces up and then push the axle out through the other axle hole. Attach the second wheel on the other end.



## STEP 5

Now, push a second axle into a wheel, insert it through the axle holes at the back of the chassis, and push the last wheel on the other side.





## STEPS 6-7

### STEP 6

Take the last axle and insert it through the holes at the top of the vertical assembly. With about 1/4" of the axle toward the outside, place an O-ring over the end to hold it in place. Place another O-ring on the other end, followed by a nylon spacer.

### STEP 7

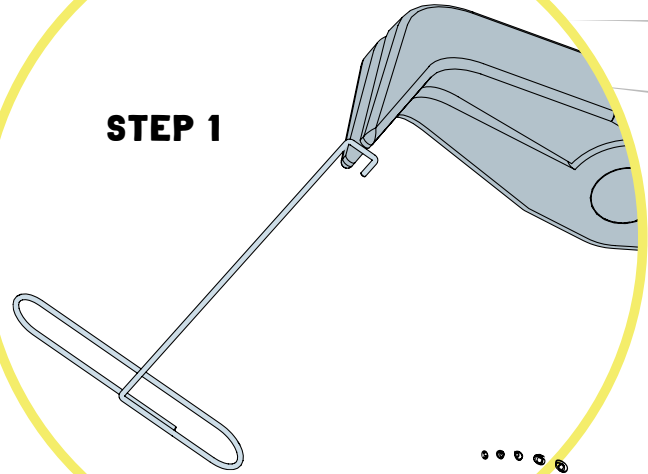
Slide the throwing arm onto the axle making sure the dowel end faces the ground. Thread the bushing onto the axle and insert into the hole on the throwing arm. Place another nylon spacer over the axle end and then secure the arm with a third O-ring.

## PREPARING TO LAUNCH

### STEP 1

Using the pliers, bend about half the long end of the paper clip facing up. Straighten that long end and make a small square hook on the end.

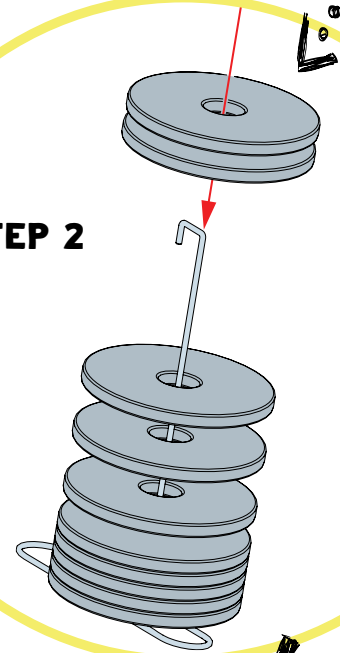
### STEP 1



### STEP 2

Place the washers over the hook end of the paper clip. This will make the mass that is used to operate the trebuchet.

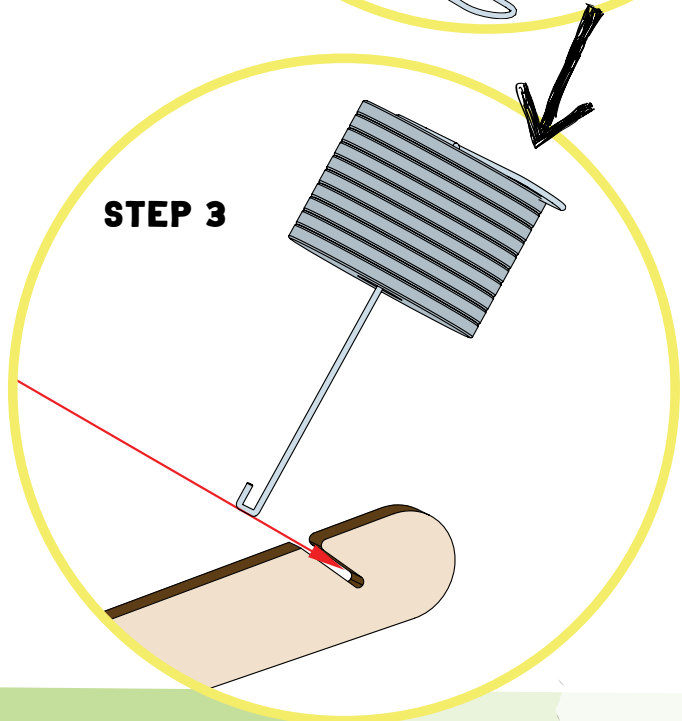
### STEP 2



### STEP 3

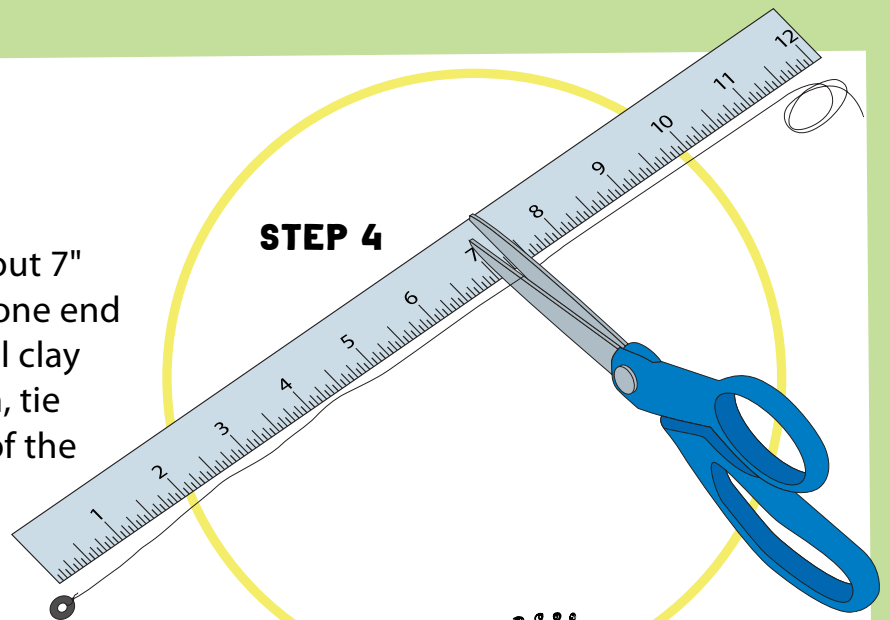
Attach the hook end of the paper clip in the angled slot on the short end of the throwing arm.

### STEP 3



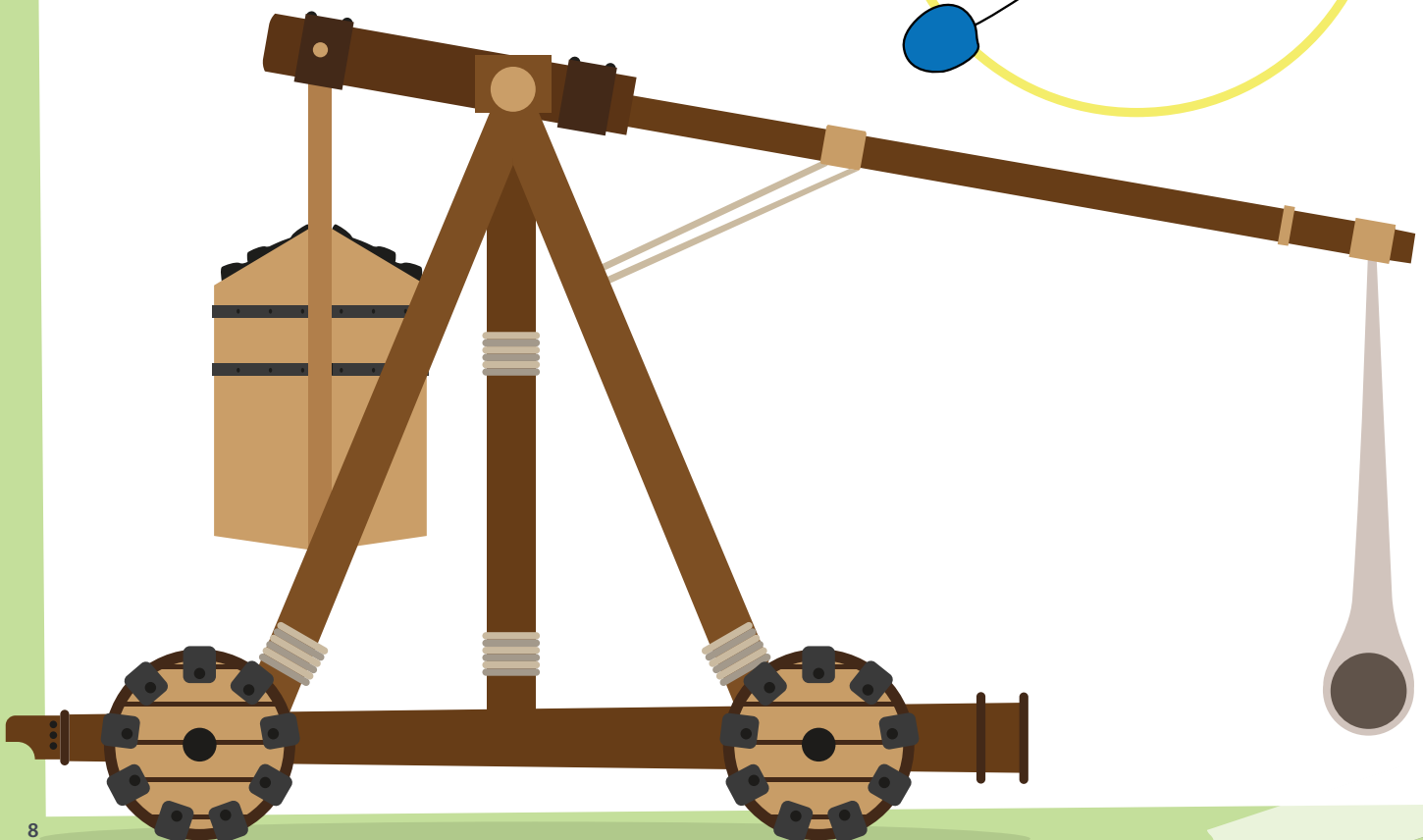
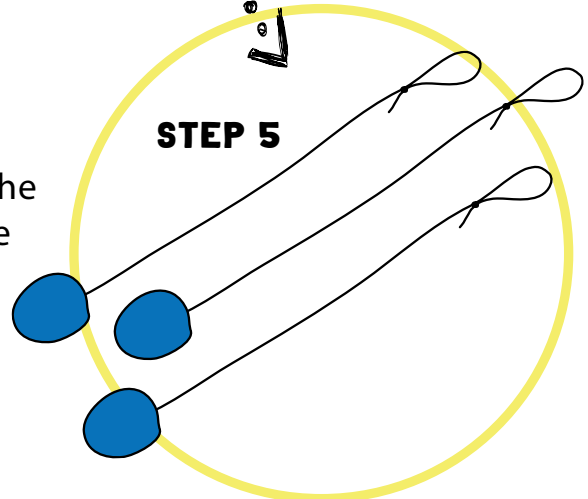
## STEP 4

Measure the string to about 7" and cut. Tie an O-ring to one end of the string. Mold a small clay ball over the O-ring. Then, tie a loop on the other end of the string.



## STEP 5

Repeat this a couple more times with the remaining O-rings and string. These are your projectiles.



# LAUNCHING THE TREBUCHET



## STEP 1

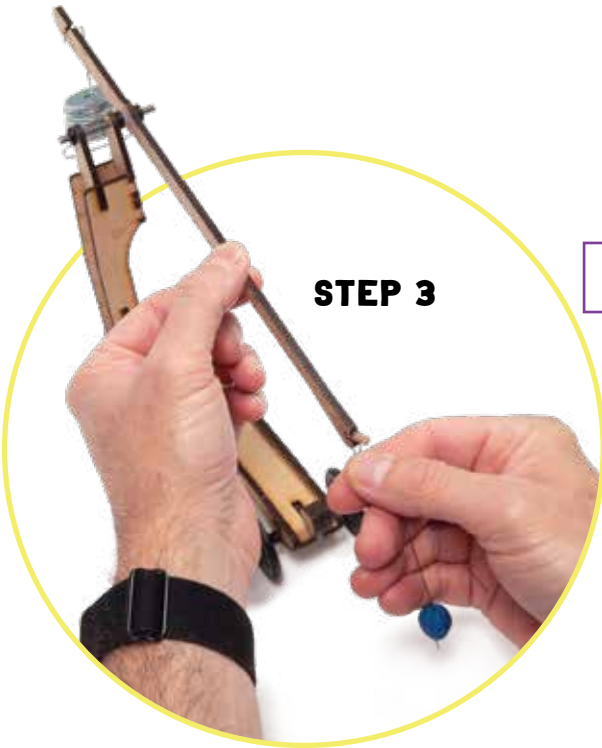
To start, use a 100 to 1 ratio of drop mass (the washers) to clay mass. If you don't have scale to measure, that's OK. Make an estimate.



## STEP 2

Place the trebuchet where you want to launch. Be sure the trigger end is facing in the **opposite** direction to which you wish to launch.

## STEP 2

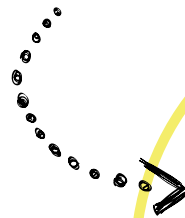


## STEP 3



## STEP 3

Holding the hook end of the throwing arm toward the trigger, hook the loop of a projectile on the dowel.



## STEP 4



## STEP 4

Secure the non-clay loop of the projectile on the hook of the throwing arm and straighten the rest of the string over the chassis.





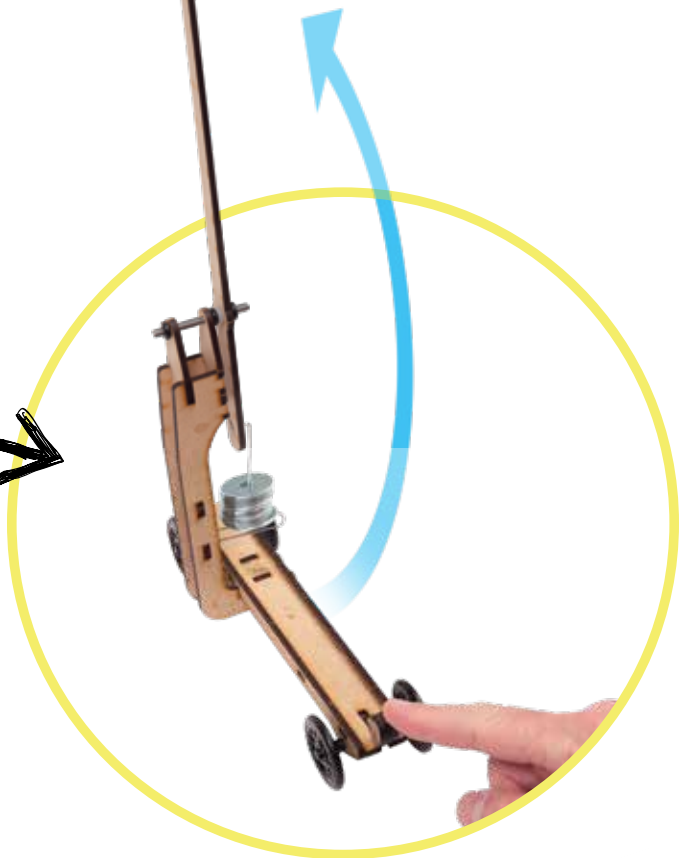
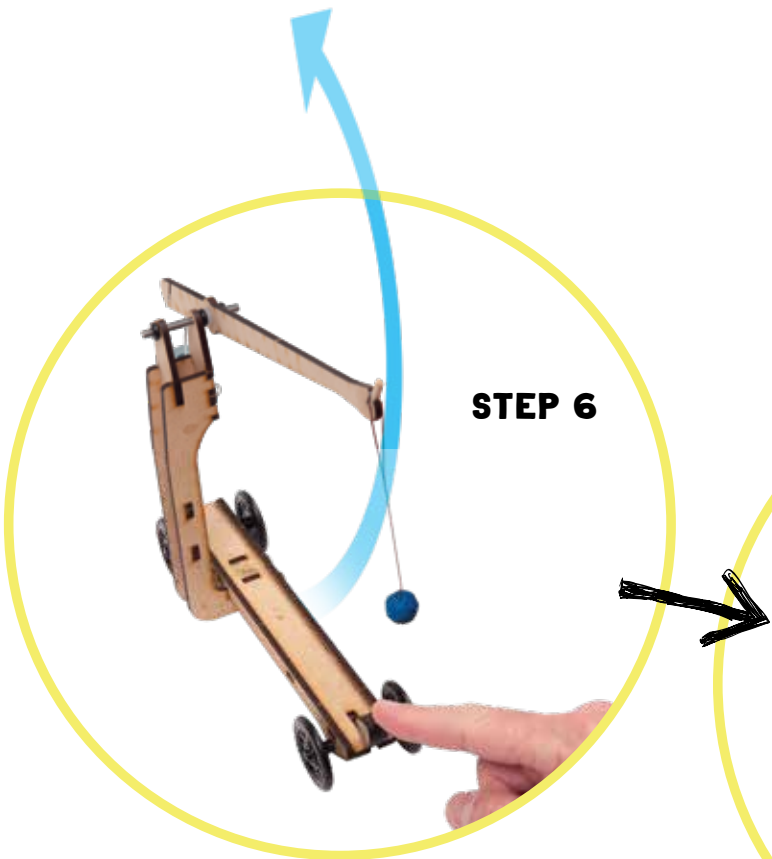
## STEP 5

Still holding down the hook, push up on the trigger to catch the hook and hold it.



## STEP 6

When ready to launch, push down the trigger and watch the projectile fly! Reload the trebuchet, and you're ready to go again.





## SAFETY

- Anyone operating the Rolling Trebuchet or nearby during its operation should wear safety glasses.
- Never use a sharp object as a projectile. Never fire at a living thing.
- Use this device only in the manner discussed and illustrated within this guide. Misuse of this product can cause serious injury.
- Make sure the launch site and flight path are clear of all people prior to launch.



## THINK ABOUT IT



Think about the different forms of energy (potential, kinetic, mechanical, and so on). Which ones are used with the Rolling Trebuchet?

If you were living in the Middle Ages and commanding the attack, how would you use the trebuchet as part of your assault? How would you defend against it?