

CATAPULT ASSEMBLY



Made possible by a grant from Google.org

How It Works

To use tension as the force for a catapult, ancient and medieval engineers used a long, flexible arm that wouldn't break when it bent backward. When the arm was released from this position, it flung forward and released the load (ammunition). The Catapult Kit uses a rubber band's elasticity to achieve the needed tension. When the arm is pulled back, the rubber band expands (action). When the arm is released, the rubber band contracts, pulling the arm forward (reaction). This illustrates Newton's third law of motion: for every action there is an equal and opposite reaction.

Ancient peoples also used torsion as the force needed to operate a catapult. Torsion is the strain in a material that is twisted. When the material is released, it resists this strain by unwinding itself. Operators twisted ropes very tightly around the catapult arm and then released them. When the twisted ropes were released, the catapult's arm would react by springing up and releasing the ammunition.

Assembly Terms

- **Mortise and Tenon** – a type of woodworking joint; a mortise is a pocket or slot cut into the wood; the tenon is opposite of the mortise and is cut to fit into it
- **Face Glue** – to glue two or more pieces of wood together by applying glue to the face of each part
- **Edge Glue** – to glue two or more pieces of wood together by applying glue to the edge of each part

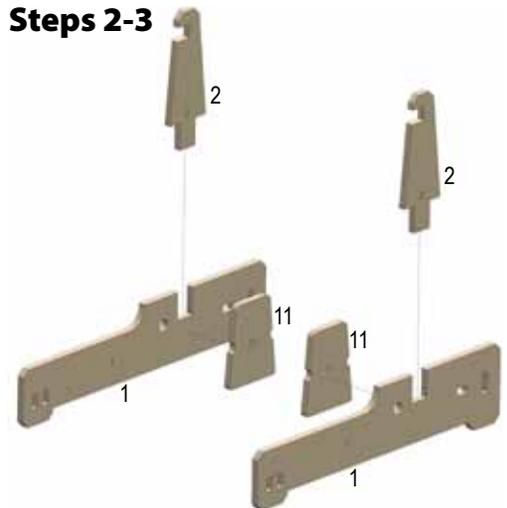
Notes

- Be careful not to use too much glue, which might make parts not fit together correctly. Wipe off any excess with a tissue or paper towel
- Place a sheet of waxed paper on your work surface to keep it clean of glue.
- Let parts dry for 15 minutes after gluing.

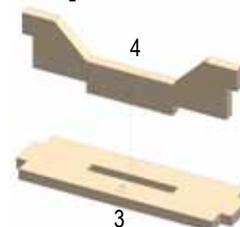
Assembling the Catapult

1. Punch out the two Part 1s, two Part 2s, and two Part 11s.
2. Apply glue on the bottom edges of Part 2. Place the tenon of Part 2 into the mortise of Part 1. Repeat for the second Part 1 and 2.
3. Face glue one Part 11 on each Part 1 and 2 assembly so Part 11 covers the assembly joint as shown. Do not cover the hole or the axle cannot be placed through it later.
4. Punch out Parts 3 and 4. Apply glue to the bottom edge of Part 4; insert the Part 4 tenon into the Part 3 mortise.

Steps 2-3



Step 4



5. Glue the tenons of Part 3 on one end of the Part 3 and 4 assembly and insert it into the mortises of Part 1 as shown.
6. Punch out the two Part 5s. Hold them together and align all three holes. If they don't align, turn one of the parts around.
7. Apply glue to the tenon on the same side of the Part 5s. Place the tenons into the mortises on the end of the Part 1 that has the Part 3 and 4 assembly attached. Apply glue to the tenons on the other side of the Part 5s and Part 3 and 4, and place them in the mortises of the other Part 1.

8. Punch out the two Part 6s. Face glue them so they are parallel.

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

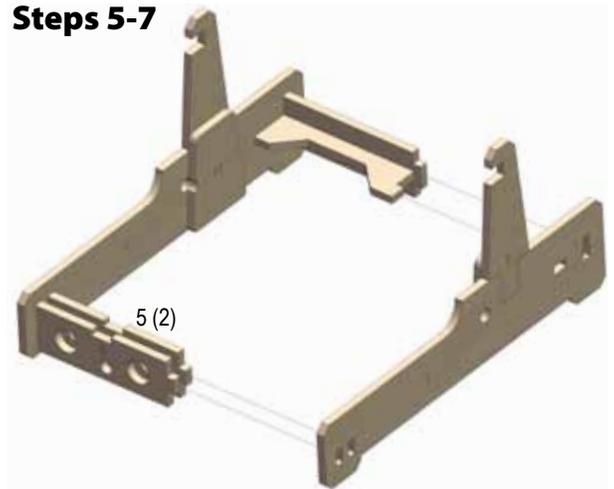
10. Punch out the Part 8s and face glue them together. This will be the catapult arm. Punch out the four Part 9s. Face glue two of them to one side of the curved end of the arm – make sure the center of the Part 9 curves are aligned with the center of the arm's curve. Hold together for a minute until they will stay in place. Glue the other two Part 9s on the other side of the arm.

11. When dry, push a 3/4" dowel through the hole at the far end, centering the arm in the middle of the dowel. Use a pencil to mark the dowel on both sides of the arm. Move the arm over and apply glue to the spot between the pencil marks. Then, slide the arm back to the center of the dowel, turning the dowel to spread the glue.

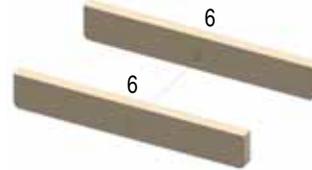
12. Punch out the two Part 7s. These will be glued at an angle between the Part 6s and Part 3 – the uneven notched end will rest on top of Part 4 and inside Part 3. Apply glue in the notched ends of the Part 7 pieces and a little on the face ends that will be against the inside of the catapult (Parts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

13. Punch out Part 10. Hold the Part 10 as shown and push the round end between the Part 5 pieces, lining up the holes. Push a 3/4" dowel through all three holes, leaving 3/8" of the dowel extending from Part 5. Apply glue where the dowel extends from the sides of the Part 5 pieces without getting glue on Part 10, which is the catapult's trigger.

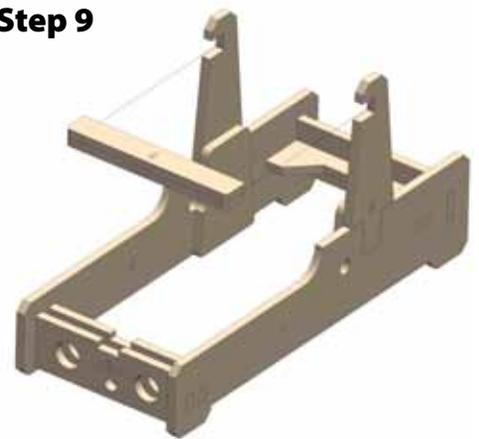
Steps 5-7



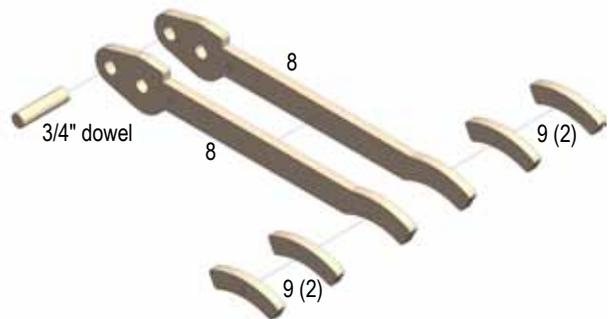
Step 8



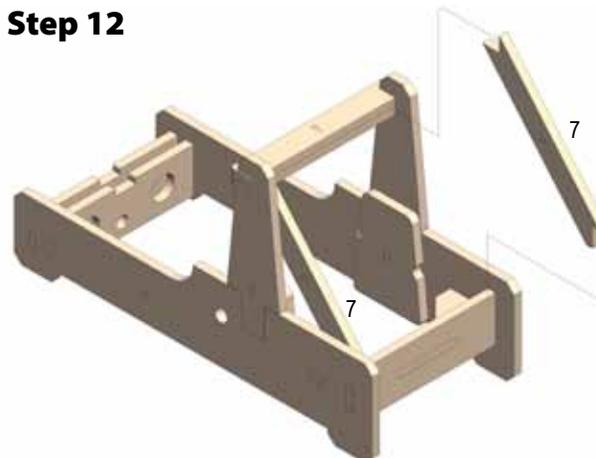
Step 9



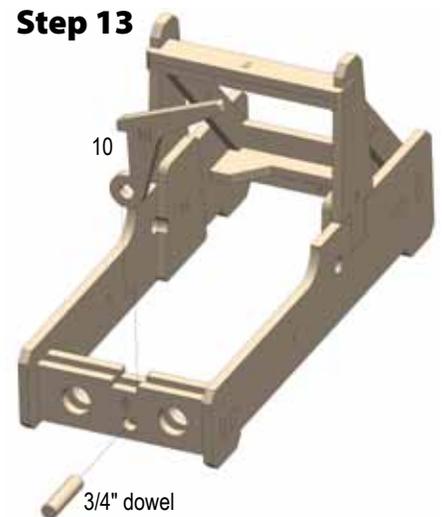
Steps 10-11



Step 12

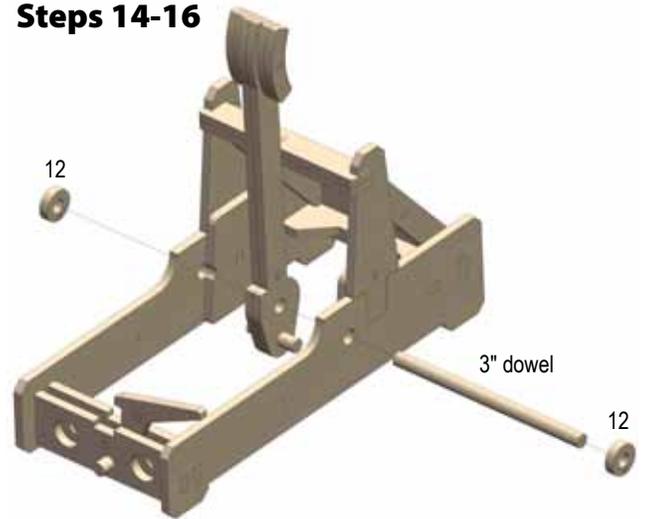


Step 13

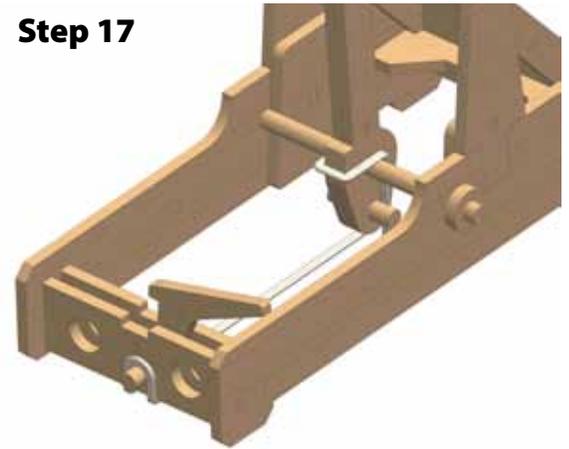


14. Insert the three-inch dowel through the hole in one side of the catapult (near the middle of Part 1) and thread the dowel through the remaining hole in the catapult arm and then out the other side of the catapult.
15. Make sure an even amount of dowel is extending from either side and that the arm is centered in the dowel. Make a pencil mark on both sides of the arm. Slide the arm over so you can apply glue between the pencil marks. Move the arm back between the marks and rotate the dowel to spread the glue.
16. 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, making sure not to get any glue between the two Part 12s and the catapult. Allow the catapult to completely dry.
17. Drop the rubber band over the catapult arm and pull the long end in front of the scoop and down between the long dowel and Part 4. Being sure to catch the ends of the short dowel on the catapult arm, pull the other rubber band end back under the catapult and over the dowel extending out from the trigger end of the catapult. Make sure the rubber band is lying flat and smooth.

Steps 14-16



Step 17



Firing the Catapult

1. Pull the arm back until it touches the frame. Raise the trigger until the notch locks the arm in place.
2. Clear the target area. Place a ball of clay in the holder. Press down on the trigger and watch the projectile fly.
3. Do not fire the catapult until everyone is clear of the target area. Do not fire the catapult at anyone.

Cautionary and Warning Statement

- This kit is designed and intended for educational purposes only.
- Use only under direct supervision of an adult who has read and understood the instructions provided in this user guide.
- Read warnings on packaging and in this user guide carefully.
- Do not aim at people.