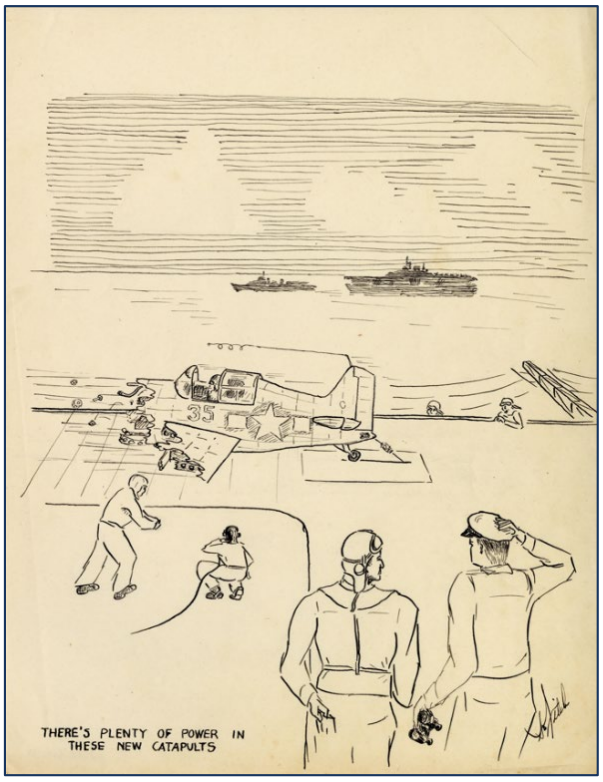
PATRIOTS POINT
NAVAL & MARITIME
MUSEUM

Historical and Modern Careers on an Aircraft Carrier

The Catapult

Aircraft carriers are essentially floating airports, with the main objective being successfully launching and recovering aircraft. With the evolution in airplanes came the need for evolving aircraft carriers both in ship structure as well as shipboard technology.



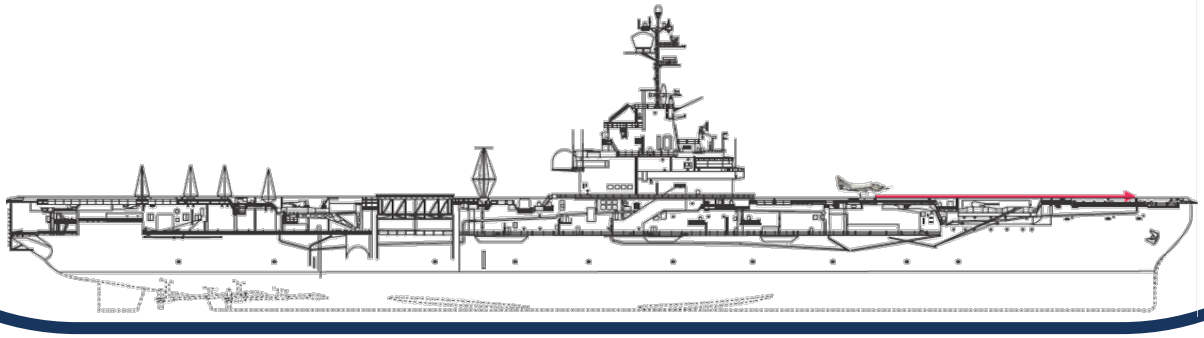
Sailor art, from the collection of Patriots Point Naval and Maritime Museum

Catapults are a testament to the scientific method: observe, question, design, experiment, fail and try again. The problem: how can a heavy plane accelerate in a short distance? The solution: the catapult. There have been many variations of them since the first person took off from a US Navy catapult in 1912.

The USS Yorktown CV-10, at Patriots Point Naval and Maritime Museum, currently has a hydropneumatic catapult of which much is visible to the public. The main idea is simple: use the potential energy stored in fluids under pressure to "slingshot" the aircraft forward. Another way to say this: a catapult turns potential energy into kinetic energy- the energy of motion.

Historically the Catapult Officer is a leader on the flight deck and known as "Shooter". Working alongside others on the flight deck they give the final "ok" for aircraft to launch. Aircraft launch and recovery officers (of which there are many) work with those that actually maintain the equipment, Aviation Boatswains Mates. AB's and ABE's perform a variety of job duties with catapults and associated equipment, including handling emergency situations. Together with the team on the flight deck they can make or break a carrier's efficiency when it comes to launching planes. The top-most performing group aboard the USS Yorktown held a record for launching 16 jets in 340 seconds! Just imagine, this was not achieved on land, but on a rocking and rolling ocean.

Some of the newest catapults are electromagnetic and a long way from the first catapults used by the Navy over a century ago. Ever-changing, engineers are always improving and redesigning machinery to increase efficiency without sacrificing performance. Along with technological advances comes a need for a work force with skillsets to match.



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About this Activity Kit

Objectives: The objectives of this kit include exposing students to ocean-going careers while engaging them in hands-on critical thinking engineering activities that reinforce cross-curricular standards in science and social studies with the potential for incorporating math extensions.

Vocabulary/themes: energy, kinetic energy, potential energy, balanced forces, unbalanced forces, technological innovation

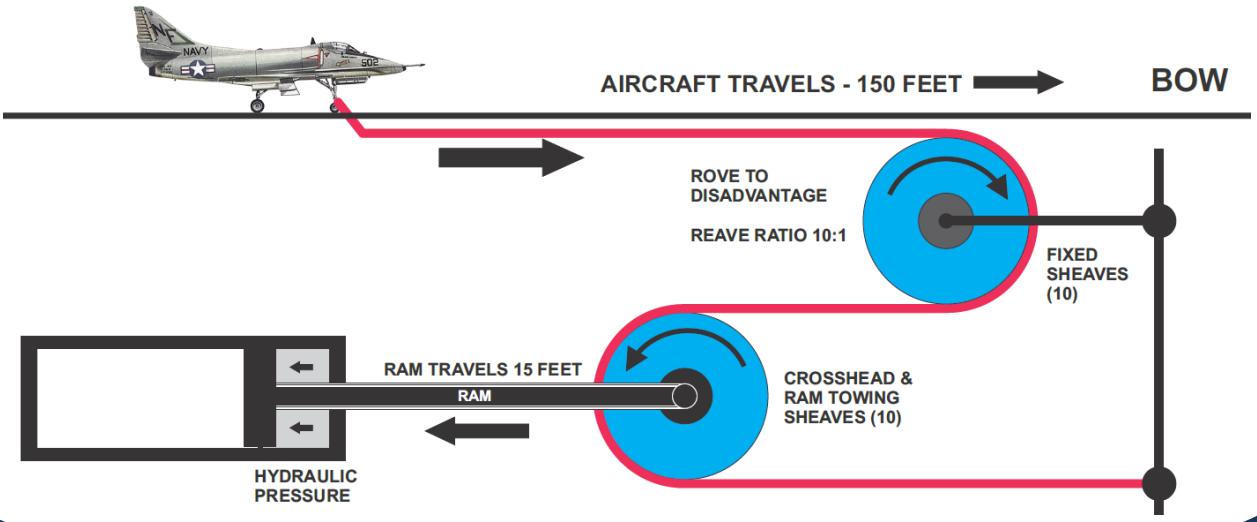
Standards Reached and/or Related to this Kit:

Grade Level	Social Studies	Science
7th		• 7-PS3-1 • 7-PS3-2 • 7-PS3-5
8th	• 8.5.CO	• 8-PS2-2
9th-12th	• MWH.4.P • USHC.5.CO	• P-PS2-1 • P-PS3-3

This kits supports SC world class skills, knowledge along with life and career characteristics.

Materials Needed (* included):

- Dowels*
- Rubber bands*
- Straws*
- Airplane and catapult component template*
- Paperclips*
- Assembly Instructions*
- Cardboard/paperboard
- Scissors
- Glue/hot glue/tape



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Activity Instructions

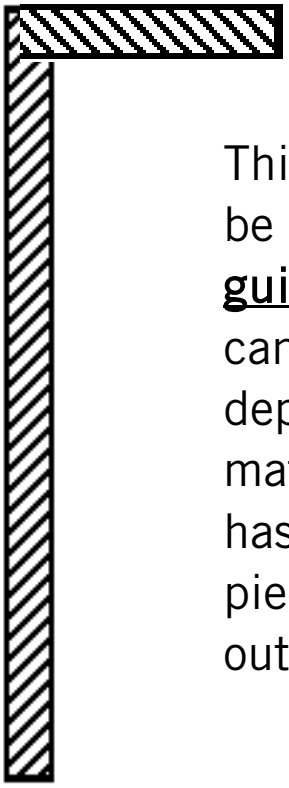
1. Have students read the background information provided about catapults.
2. Review with student's NOAA's engineering design process at https://oceanexplorer.noaa.gov/edu/materials/engineering-design-process-handout.pdf
3. Preview the end result of a working catapult here: https://youtu.be/10lx90UIk2o
4. Gather materials. Cardboard, paperboard or other found materials may be used for the carrier structure and catapult sheaves.
5. Use templates and assembly instructions to construct and refine catapults with students in small groups; this could include refining the paper airplanes.

Activity Options

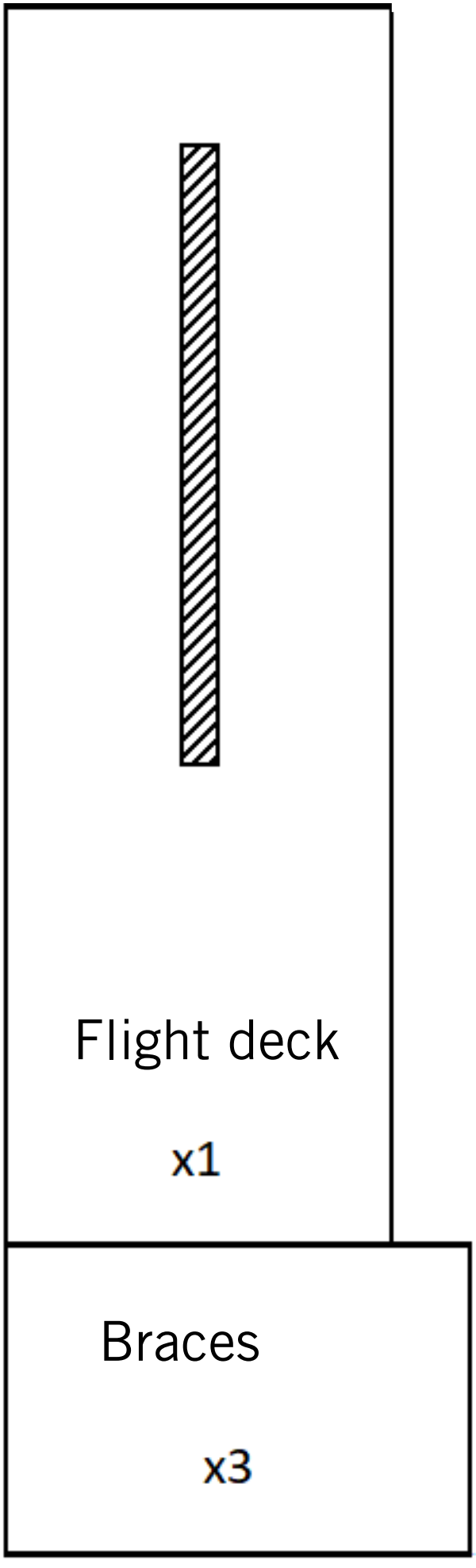
- Give students an allotted amount of time to refine their catapult and then have student groups present to the class; during the presentation students should point out potential energy, kinetic energy, transfer of energy, balanced forces, unbalanced forces and other vocabulary words selected by the teacher
- Have student groups compete to see whose aircraft flies the farthest
- Ask students to use any materials they would like to re-engineer their catapults using the same basic components and structure.
- Have students calculate the speed of their aircraft. There are many resources describing how to do this using a smartphone to video and then analyzing the video frame-by-frame (often this option is either built in or available for free download from an App store) with the object traveling a known distance.
- Challenge students to attach syringe hydraulics to release
- Explore the sheaves, reave and rove ratios
- Have students research the evolution of catapults in the Navy and place these technological advancements in the context of global events, especially as it relates to the aircraft carrier's relevance, to reinforce the connection between engineering, technology and society.

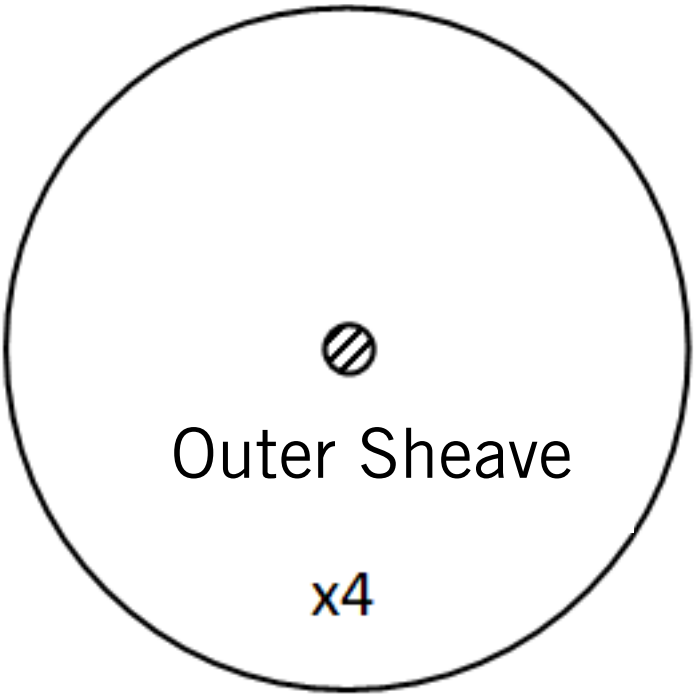
Side Panels

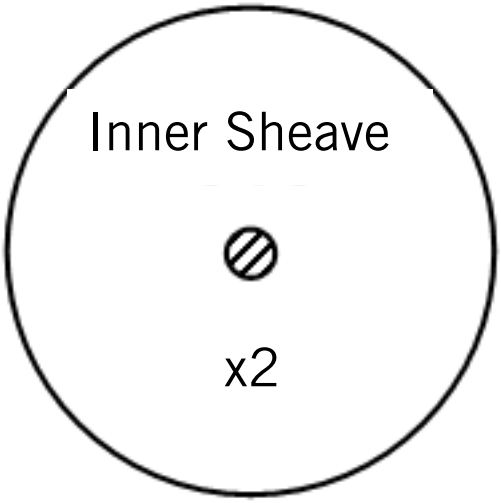
x2



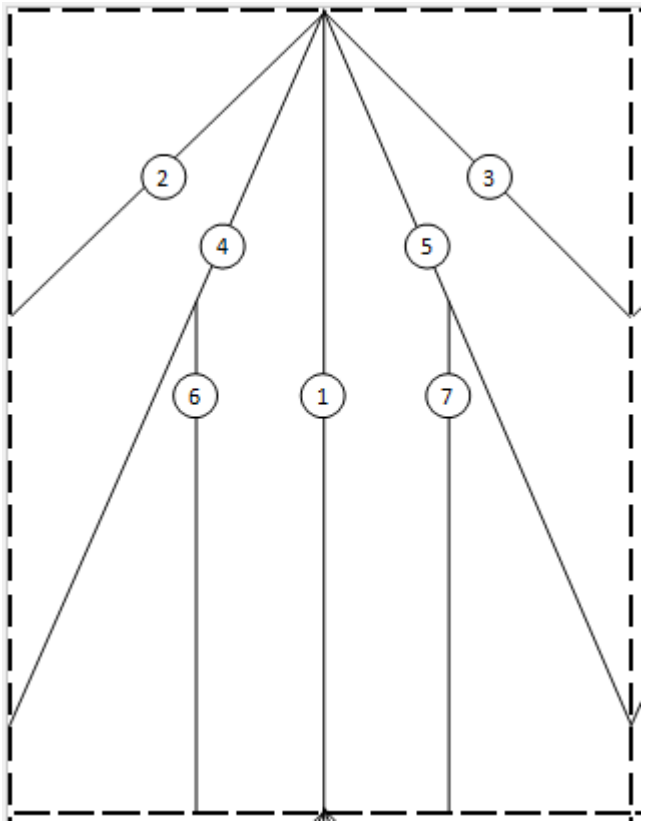
This template should be used as a **shape guide**; different sizes can be used depending on the materials selected; hash marks are where pieces should be cut out.







Braces should be cut last and be wide enough to support the bottom and one side of the catapult.



To start, use a basic airplane design such as above, keeping it small, as suggested by the size of the template.

1. Fold in half
2. Folds 2 and 3 are folded back (otherwise on the outside of the plane)
3. Folds 4 and 5 are also folds that fold back or towards the outside
4. Lastly fold 6 and 7 to the outside

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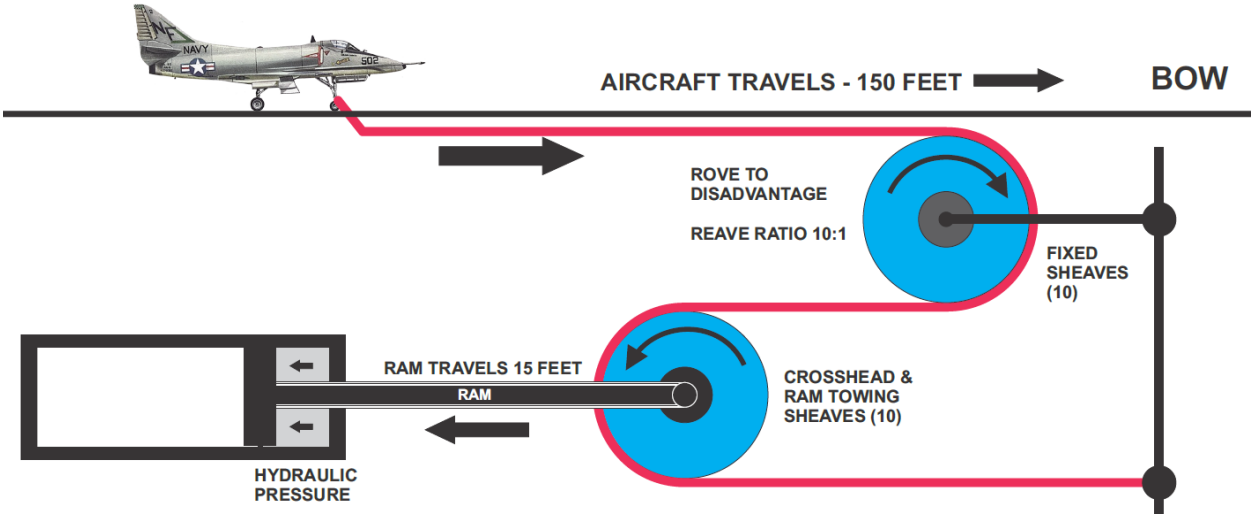
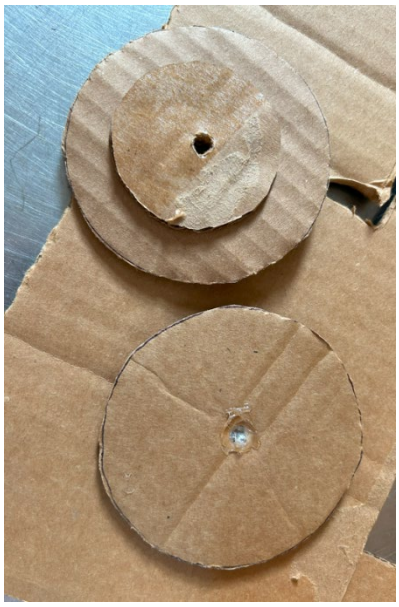
Assembly Instructions

1. It is crucial to understand several things:
    a. How the catapult works/structure
    b. Keep in mind the end product
    c. That materials and template sizes need not be exact and can be altered and refined
2. Basic catapult structure:

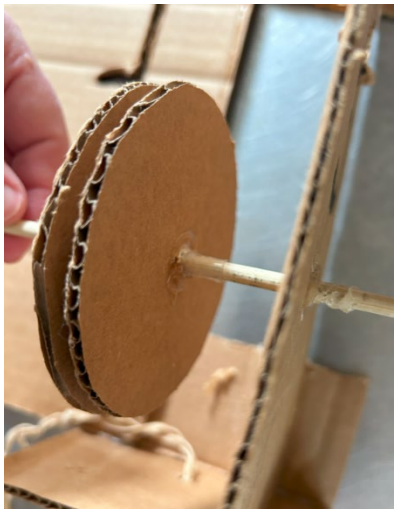


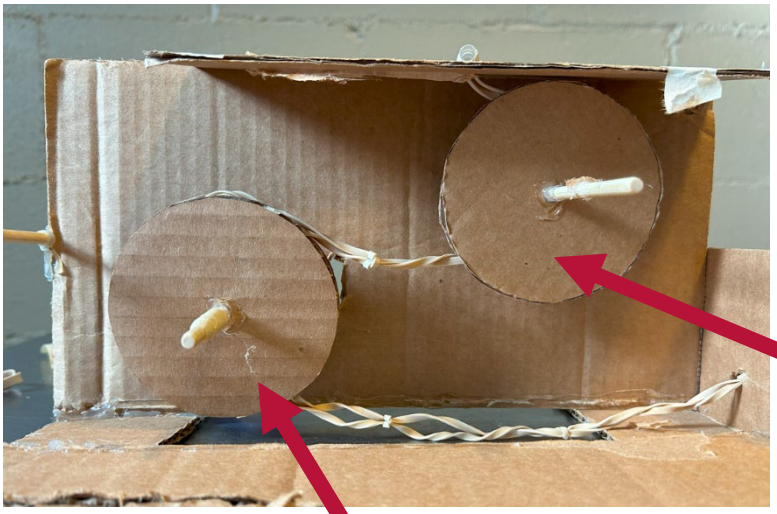
3. End product: https://youtu.be/10lx90UIk2o
4. Ultimately the blue sheaves will be cardboard and the red cables will be rubber bands placed in almost the same position relative to one another as the graphic.
5. First, cut out all cardboard components- the sides, flight deck, inner and outer sheave pieces
6. Assemble the sheaves by sandwiching one inner sheave between two outer sheaves and securing with glue, being careful to keep the center clear.
7. Insert a straw, about 1.5 inches in length through each sheave. Secure with glue.



Have students brainstorm why the straw is necessary and what force it is reducing.

8. Place a dowel rod through each assembled sheave. Sheaves need to spin freely.
9. At this point you will want to have one wall up and secured to cross braces across the bottom so the sheave that is fixed and on the upper right can be installed. These next steps will benefit from several sets of hands simultaneously.

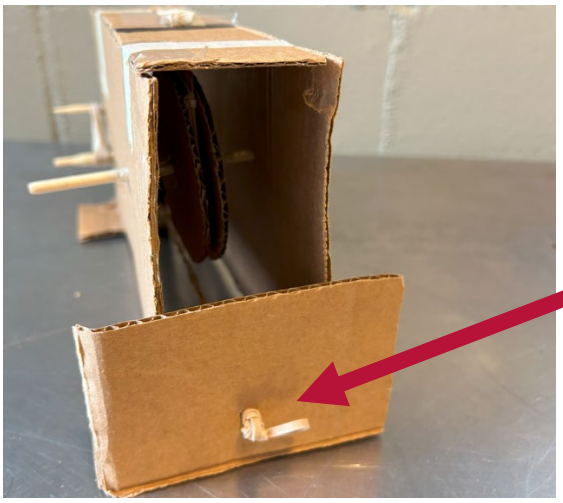




This sheave is stationary and the rod is secured to both side walls.

This sheave and the dowel rod it is on moves in the long slot. To set the catapult for shooting the plane, it is set forward and up.

10. Now is a good time to connect your rubber bands to create your cable. 7-11 rubber bands should do the trick if your sides and sheaves are similar to the templates. This is a fine balance that can be tuned. Start with a lower number and after completion if the catapult is too hard to set for shooting then add more. Leaving the bottom mostly open helps with being able to adjust.
11. Anchor the cable to the front support brace closest to the fixed sheave.

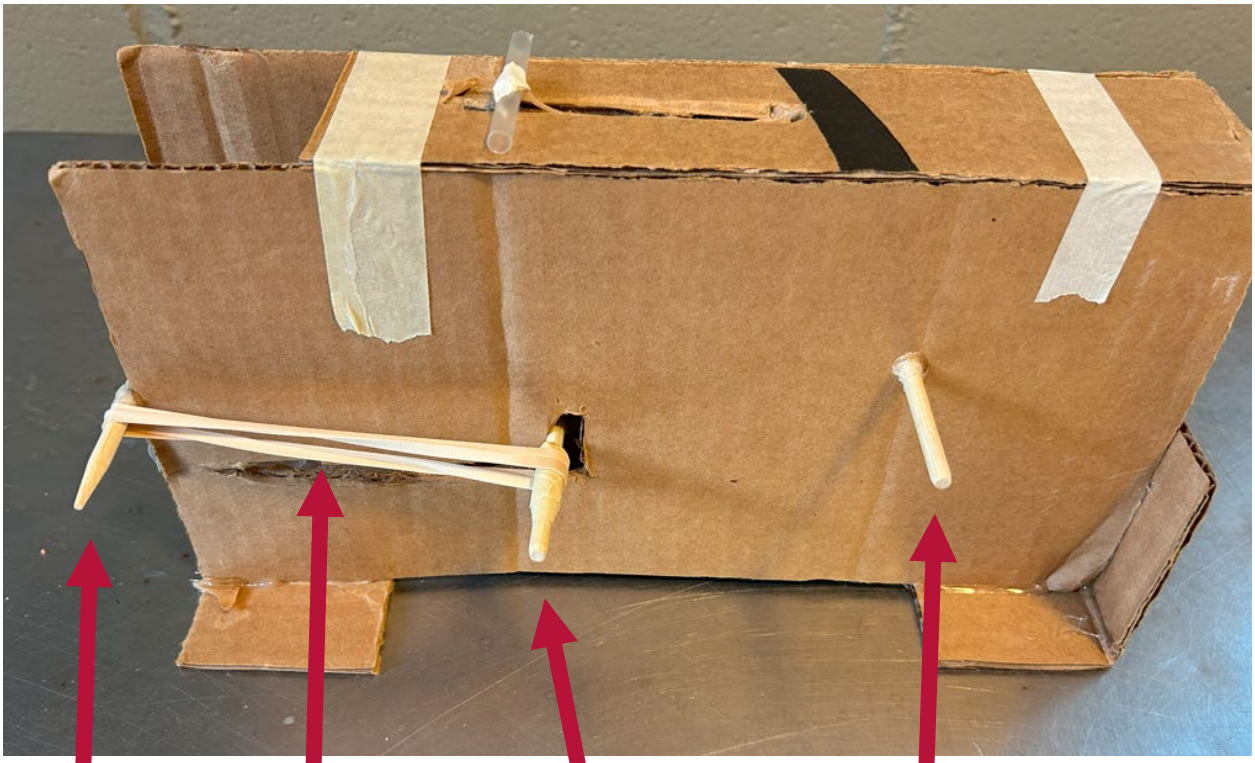


Knotting the rubber band after pulling it through is the best option.

12. Get your moveable sheave and dowel rod in position.
13. Now add your flight deck and make sure to add launching gear to then end of your cable. Your launching gear is a piece of 1.5 inch straw that will be perpendicular to your flight deck.

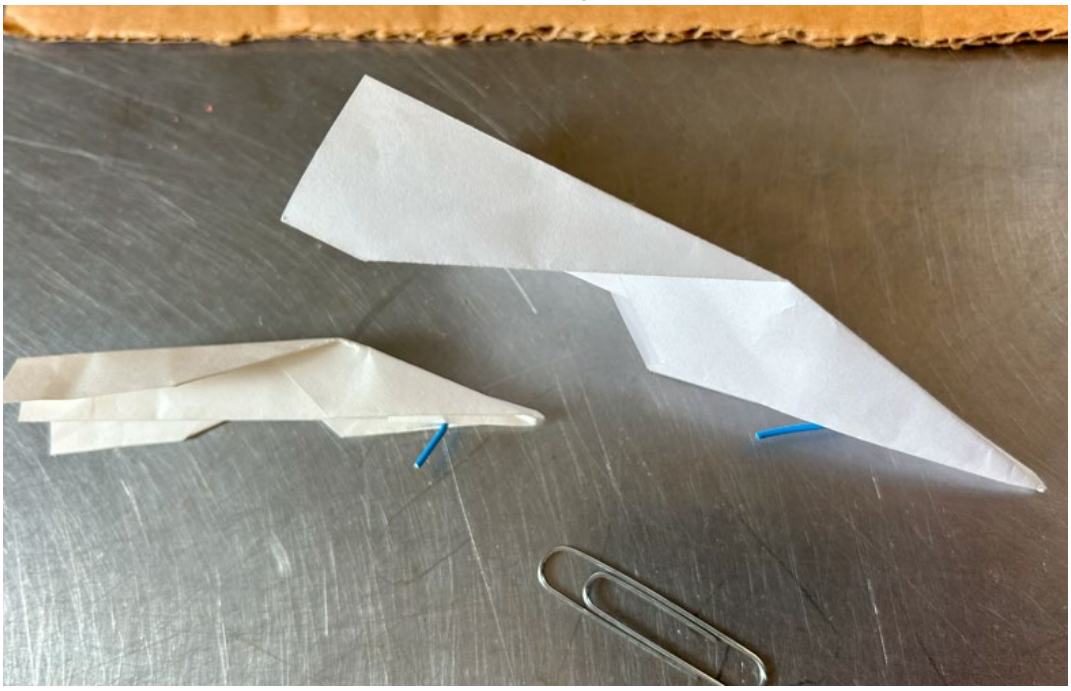
14. Thread your cable through your sheaves as shown on the previous page.
15. Add the second sidewall and secure the stationary sheave.

16. Your movable sheave will rest in the slots of your sidewall.
17. A dowel rod for your movable sheave will need to be installed.
18. A rubber band (folded over on itself/doubled) will be used to connect your sheave to the fixed dowel rod (step 17) and act as your ram. Do this on both sides.

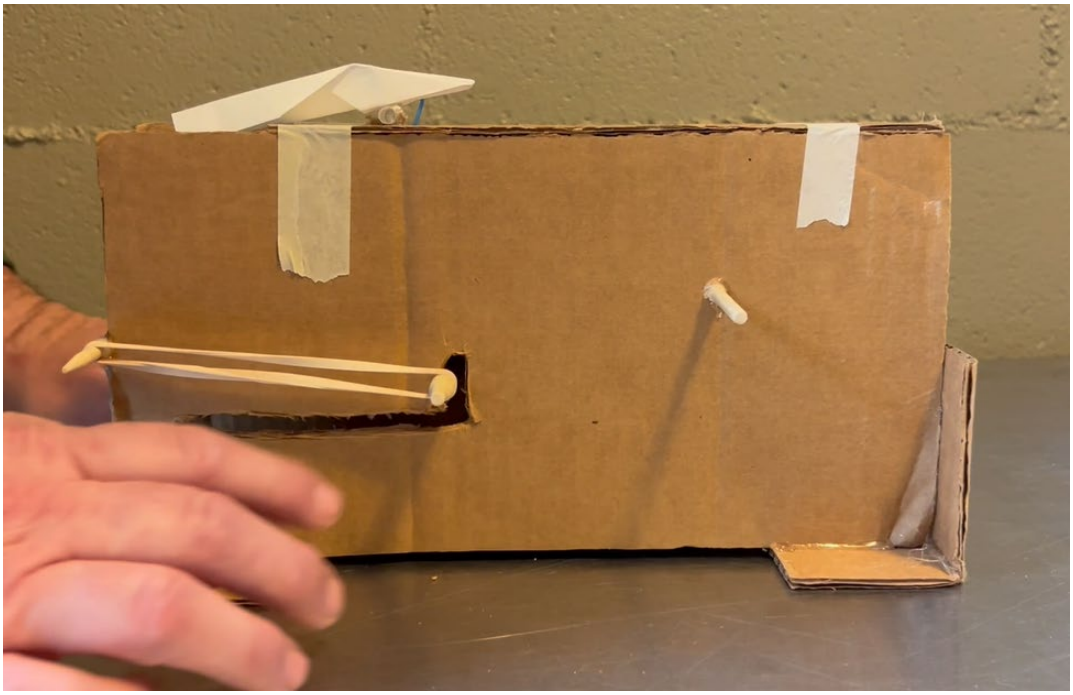


19. Create paper airplanes with template. Alter size or materials if needed. Index cards and heavier paper work well.
20. See the following page for last details on airplane launching gear (paper clip) and catapult settings.

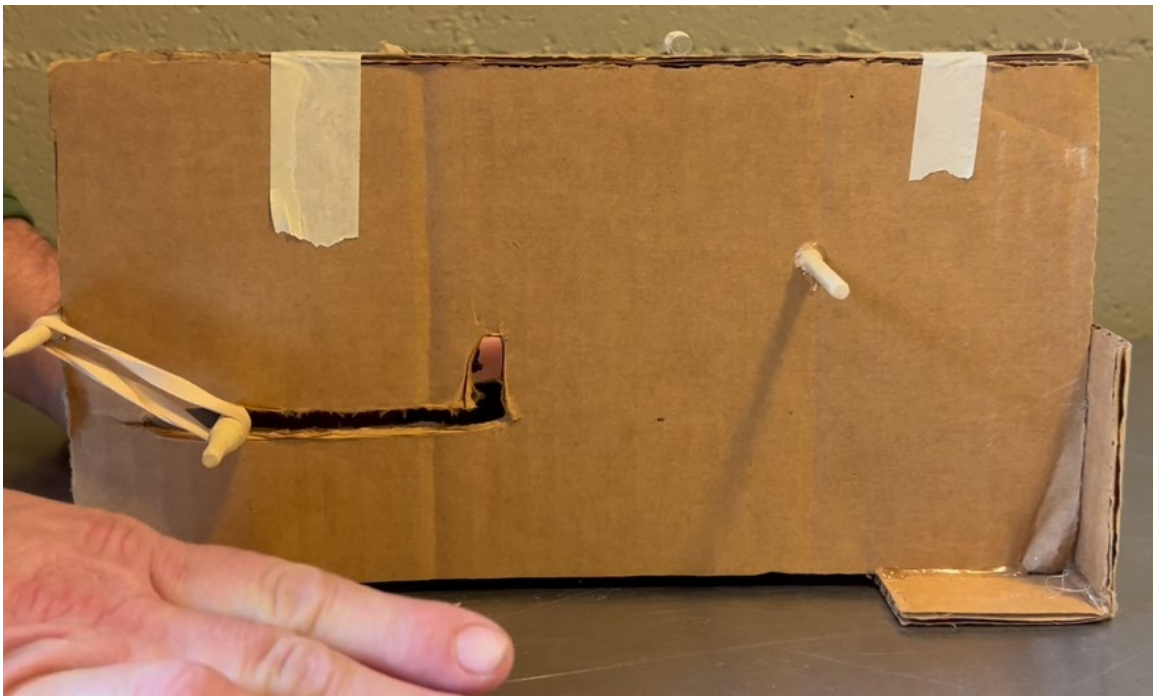
21. Use a paper clip (can be cut with scissors) as launching gear for your aircraft. Poke through aircraft, centering down fold number 1 and secure with tape.



22. To launch, slide the moveable sheave forward and up. Pull launching gear on flight deck back. Place plane on flight deck with paperclip “gear” resting on the straw.



23. After launch, by releasing both sides of the moveable sheave down at the same time, the flight deck gear will have moved forward and the moveable sheave will have moved down and back.



Ready for Take Off!