Catapult Levers

This activity shows the three orders of lever in a clear and engaging way. Students begin with construction of one of the three lever catapults below, and then can use their catapult for a range of investigations. **Take extra care with the Stanley knife in step 6.**

The simple design of the catapult allows for variables to be changed and testing of different hypotheses, providing opportunities for deeper investigations. There are also opportunities to introduce variables at the construction stage, challenging students to think through the theory then use it to create a more effective catapult – e.g. students could predict which exact positioning of load, fulcrum and effort will shoot the ball the furthest.

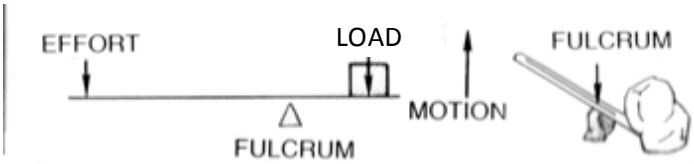
Tools required

- Pen
- Stanley knife
- Drill and drill bit

Curriculum links / possible uses

- Year 7, ACSSU117 – simple machines and levers (focus here)
- Year 8, ACSSU155 – kinetic energy, elastic potential energy (not the focus here)
- Year 10, ACSSU229 – Newton's Laws (not the focus here)

First Order Lever Catapult



https://en.wikipedia.org/wiki/Lever#/media/File:Lever_%28PSF%29.png

What you need:

- 2 paper box lids
- 5 paper fasteners (split pin type)
- 1 small foldback clip
- 1 rubber band
- 1 bottle lid
- sticky tape
- ping pong ball

What to do:
(The final catapult is pictured over)

1. Place one box lid on its end in the middle of the other box lid. Make a pilot hole with the pen, then secure with a paper fastener on each side.

2. Drill a hole in the middle of the ruler big enough for the fastener split pins to go through. *Extension: change the hole position.*

3. Attach the ruler near the top of the upright box using a paper fastener.

4. Insert a paper fastener in the end of the base box. You can reinforce the hole with tape first for longevity (this hole supports the effort placed on the lever).

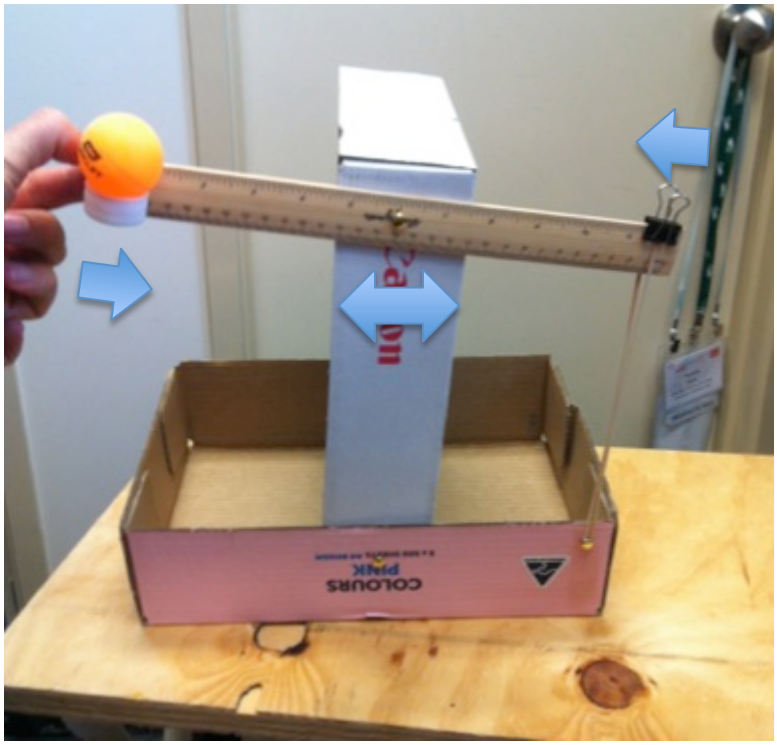
5. Loop a rubber band around the fastener, then attach the other end to the end of the ruler and secure with the foldback clip. *Extension: reposition the rubber band to change where the effort is applied.*

6. Use the end of the Stanley knife blade to make a slit width-wise *across* the side of the bottle lid, and *lengthwise* in the end of the ruler (not the rubber band end). The slits should be positioned so the bottle lid attaches to the ruler as per the image. The slits need to be big enough to allow a fastener to be inserted. *Extension: Change where on the ruler the lid is attached, or attach multiple lids to compare.* **Take extra care to avoid injury; use a sharp blade and slowly wiggle the blade through to cut. Teachers may like to pre-do this step.**

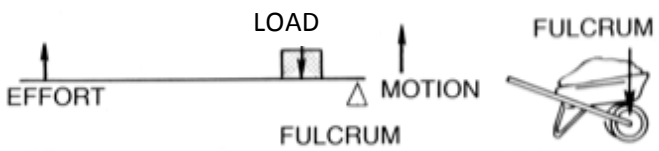
7. Attach the lid to the ruler using a fastener.

8. Your finished first-order lever catapult is ready for launch! Use a lightweight, safe projectile like a ping pong ball.

9. *Extension: suggestions for variables and more open-ended investigations – such as moving the load, effort and fulcrum – are indicated with arrows. These variables can be changed between students/groups and comparative data collected across the class. Changing the load (a heavier ball) is another option, but safety first.*



Second Order Lever Catapult



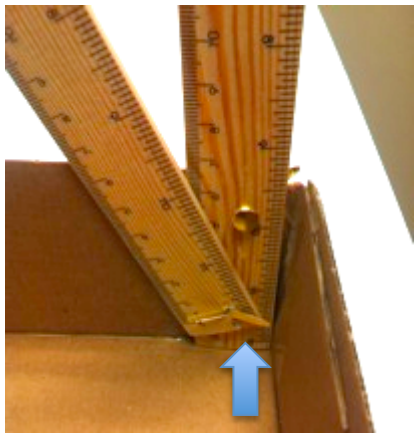
What you need:

- 1 paper box lid
- 3 paper fasteners (split pin type)
- 2 small foldback clips
- 1 rubber band
- 1 bottle lid
- sticky tape
- ping pong ball

What to do:
(The final catapult is pictured below)

1. Reinforce one corner of the box lid with sticky tape.

2. Hold one ruler upright in the corner and use the pen to make two pilot holes through the box to the ruler. The bottom hole will also be used for the moving lever arm, so make it about 3cm from the base so the lever can pivot freely.

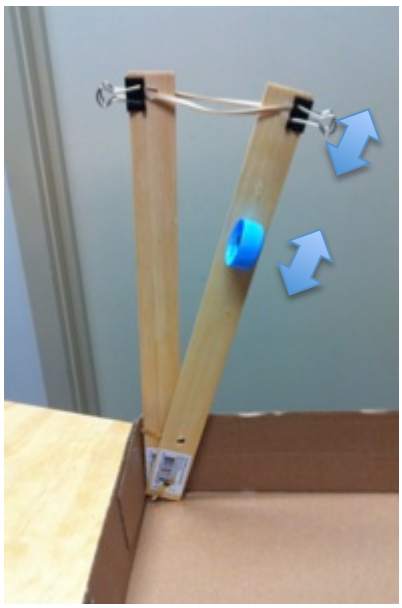


3. Drill two holes in the ruler as per the marks you just made.

4. Drill one hole in the end of the other ruler, ensuring the hole placement will allow it to pivot (note ours is slightly offset as per the arrow; see image).

5. Attach the rulers with paper fasteners – the bottom fastener goes through both rulers, while the top faster only goes through one.

6. Attach the bottle lid to the **middle** of the pivoting ruler, as per steps 6-7 of catapult one.

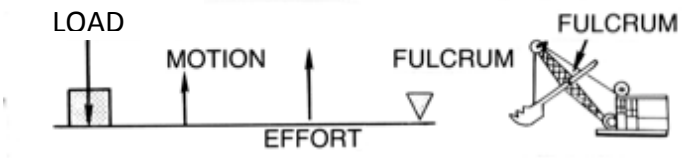


7. Loop a rubber band around the top **ends** of two rulers. Use foldback clips to hold in place. *Extension: change the height, or relative heights.*

8. Your finished second-order lever catapult is ready for launch! Use a lightweight, safe projectile like a ping pong ball.

9. *Extension: suggestions for variables and more open-ended investigations – such as moving the load and/or effort – are indicated with arrows. These variables can be changed between students/groups and comparative data collected across the class. Changing the load (a heavier ball) is another option, but safety first.*

Third Order Lever Catapult



What you need:

- 1 paper box lid
- 3 paper fasteners (split pin type)
- 2 small foldback clips
- 1 rubber band
- 1 bottle lid
- sticky tape
- ping pong ball

What to do:
This catapult is the same as the second order version, with the effort and load swapped.

1. Reinforce one corner of the box lid with sticky tape.

2. Hold one ruler upright in the corner and use the pen to make two pilot holes through to the ruler. The bottom hole will also be used for the moving lever arm, so make it about 3cm from the base so the lever can pivot freely.

3. Drill two holes in the ruler as per the marks you just made.

4. Drill one hole in the end of the other ruler, ensuring the hole placement will allow it to pivot (note ours is slightly offset as per the arrow; see image).

5. Attach the rulers with paper fasteners – the bottom fastener goes through both rulers, while the top faster only goes through one.

6. Attach the bottle lid to the **end** of the pivoting ruler, as per steps 6-7 of catapult one.

7. Loop a rubber band around the **middle** of two rulers about half way up. Use foldback clips to hold in place. *Extension: change the height, or relative heights.*

8. Your finished third-order lever catapult is ready for launch! Use a lightweight, safe projectile like a ping pong ball.

9. *Extension: suggestions for variables and more open-ended investigations – such as moving the load and/or effort – are indicated with arrows. These variables can be changed between students/groups and comparative data collected across the class. Changing the load (a heavier ball) is another option, but safety first.*