AJBOX EDUCATIONAL KITS

Teachers Project Guide

EDUCATIONAL RUBBER BAND CATAPULT

SUMMARY:

‘Educational Rubber Band Catapult kit’ (RB Catapult) by AJBOX is an educational STEM focused mechanical kit which is supplied as a set of 12 kits, pre-cut out of Plywood. The individual kits can easily be snapped out by hand and each one is intended to be built by students individually or in pairs.

Each kit is complete with all necessary parts and just needs assembling by hand without needing any tools. Gluing is optional.

HOW TO USE THE KITS:

You can use them in a variety of educational approaches, or as a standalone STEM activity. Two suggested lesson topics are:

1. Science - Storage and release of energy. Effect of mass on moving objects

2. Mathematics - Relationship between angle and distance. Adjust rubber band tension and graph relationship between tension (Force stored) and distance using a standard load

HEALTH AND SAFETY:

The laser cutting process produces a small amount of fine dust which is the smoke produced by the laser burning out the shapes in the kit. Like any fine dust, rarely somebody may be sensitive to it. It is not recommended to wash the kits because the wood will swell and distort, but you can use any brand of spray furniture wax to seal the dust in if you believe it may be a problem.

Some students find the unique burnt plywood smell attractive and you may need to discourage them from sniffing the pieces.

The Plywood is made from layers of Birch wood glued together with a PVA glue. It is non toxic but care should be taken because of potential splinters.

BEFORE YOU START:

I urge you to build a RB Catapult kit yourself and practice with it before you work with a class so you are familiar with the pieces, the order in which they are assembled and how to make it work effectively. The assembly video is a good place to start as it shows how to assemble and spin it. AJBOX sells a range of other mechanisms, including torsion and flexible catapult kits as well as crossbows and other projectile devices.

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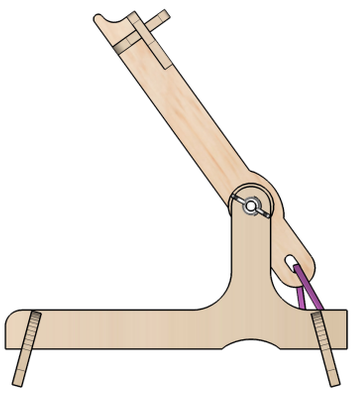
HOW THE RB CATAPULT MECHANISM WORKS:

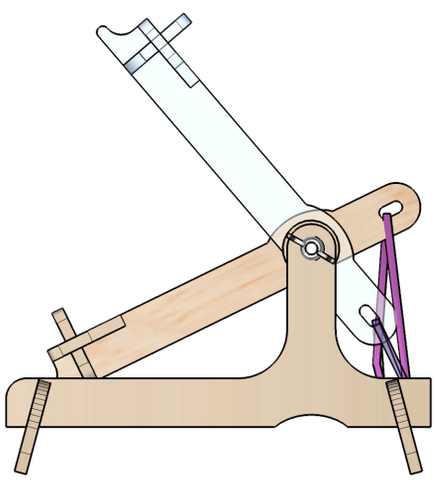
Simply, you stretch the band by pulling down on the opposite end of the arm, then it moves back again quickly when you release it, but there's actually a lot more going on than that..

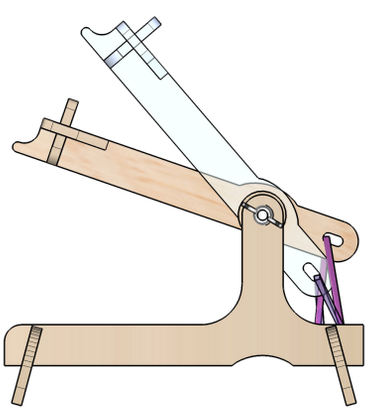


In its initial 'neutral' position, the rubber band is slightly tensioned and this pulls the arm. As the rubber band wants to contract to the smallest length possible, it is pulling on the arms short end, raising the long end in the air. In fact the long end is actually sagging down slightly because the weight of the arm itself pulls against the rubber band, but with such a low mass of the arm, this sagging is probably imperceptible, but it is there.

Pulling the arm down, stretches the rubber band. You use energy to push the arm down, and this energy is used to stretch the band. As this energy is (mostly) returned when you release the arm, we call it 'stored energy', or 'potential energy'.

There is a little bit lost through the friction within the arms plastic bearing, and also within the band as the rubber molecules slide across each other, but most of the energy is released when you fire the catapult.





As the rubber band contracts, pulling the arm, the arm moves fast and its mass , combined with its speed, means it takes more energy to stop it, just as catching a ball takes more energy than just holding it. This means that when the arm swings up, pulled by the contacting rubber band, the arm will actually swing beyond the neutral position, before swinging back and forth around the neutral position and stopping. A modern smart phone with a good video slowdown mode should show this.

This means that the arm stops moving forward at different points depending on how far you pull it back as the more you pull it back, the more force = speed = momentum in the arm.

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Teachers Notes

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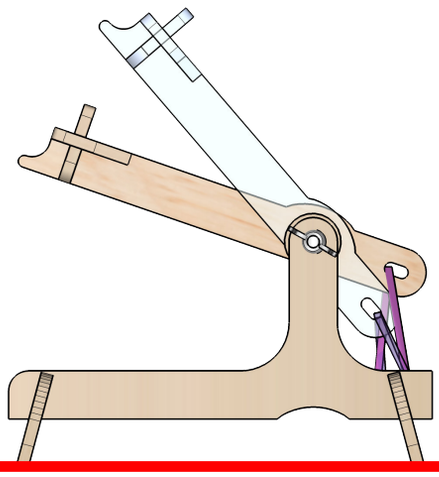
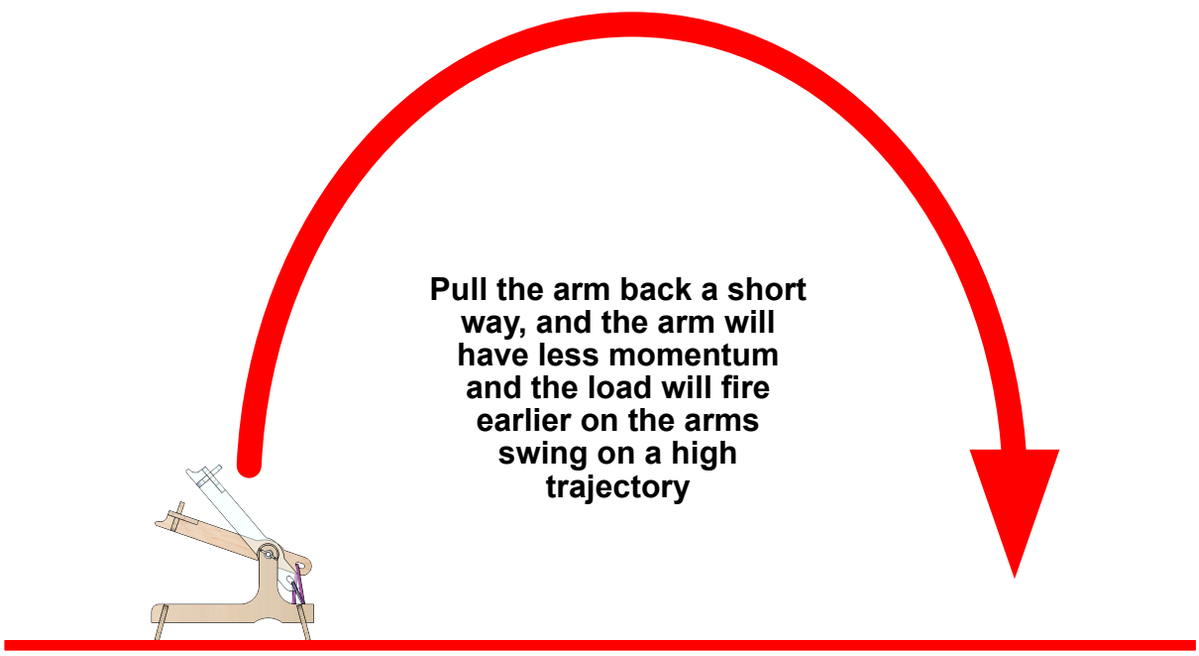
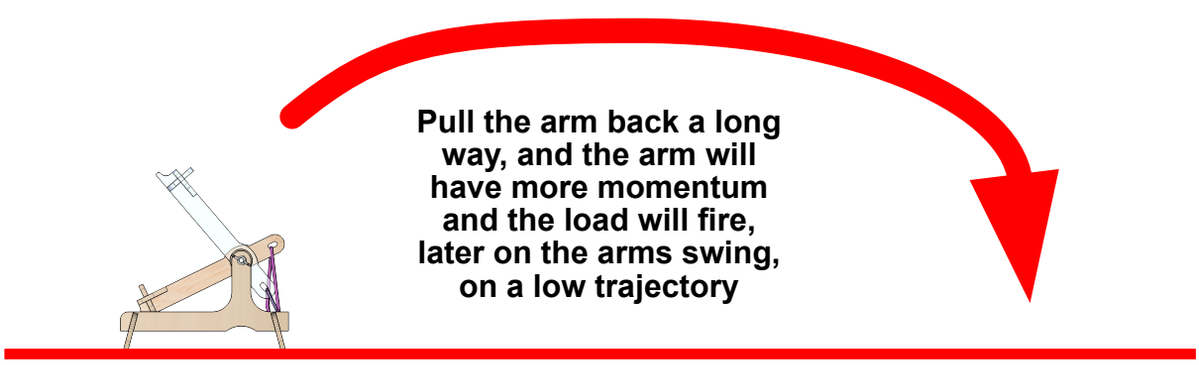


After the band reaches the neutral position, the momentum of the arm keeps it moving further past the neutral position, then the band pulls it back again, braking the arms movement through the band stretching and contracting repeatedly, but the load carries on.

The Trajectory (Path through the air) of the load (if you use the same mass load each time) is therefore alterable by how far back you pull the rubber band.





Of course, the distance travelled by the load will also be affected by how hard you pull the arm back, so try getting students to make a little card gauge for the side of the catapult and test it with a standard load, like a marble. Firing into a sandpit, the marble will stay where it first lands..

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PROBLEMS:

The Plywood kits are robust but over time the arm may wear around the plastic bearing, but this will take a long time. Occasionally when you push a piece out, a defect (a hard or softer area) inside the plywood means it is difficult to use the piece. This is rare but if you have this problem, just contact me with a photo of the broken piece and I will send you out a free replacement piece.

COLOURING AND DECORATING:

The surface of the Plywood takes pen and pencil well but it is recommended that any wet process such as large glued on pictures or paint is applied after the kit is assembled so that pieces do not swell and become difficult to assemble later. Varnishing is best done after assembly as it makes pieces thicker.

AGE GROUPS:

Use the RB Catapult as a STEM making activity and refer to the scientific principles in passing, and you could use it with ages from about 6 upwards. Incorporate the scientific principles more, maybe get students to try some adaptations (Such as seeing the effect of different weight loads) and you could use it with ages 10 and up. As a problem solving exercise where students accurately measured the arms angle before firing, the mass's weight and plot the distances to create graphs, then they should be able to draw conclusions about the distances for other loads, and it would be suitable for much older students. Adults will be equally fascinated with it and want to experiment and learn more.

Regardless of the age group,this kit **is not suitable for ages 5 and below,** and should only be used with adult supervision for those under 16 as overenthusiastic users may damage things.. Or people, and the kit contains small parts.

EVERYONE needs to wear eye protection.

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ASSEMBLY TIPS:

- Use the ‘Assembly’ worksheet which is an A3 ‘shadow board’ that students place the pieces onto, to ensure they haven't thrown anything away by accident. This can be folded up to make a pouch for storage between lessons
- Encourage students to discard the ‘sprue’ (Unwanted bits) as these can have pointy edges. These can be composted or burnt like other wood materials
- Assemble in the recommended order only. In the shadow sheet, video and the presentation are the same assembly stages
- If some pieces do not seem to line up, check you are putting the pieces together properly
- If the finished mechanism does not work easily, don’t force it, first check everything IS in the right place and the right way round. Then try slackening the wing nut a bit as overenthusiastic tightening will clamp the arm between the side pieces, stopping it moving freely
- Glue is not necessary to make a working mechanism, but it can help where students may be rough with the assembled kit. You can use Glue Sticks or standard white glue (PVA) to join the pieces together. As the Plywood pieces swell when they get damp, you need to assemble the pieces quickly after applying the glue
- You can tighten or slacken the rubber band by taking ‘extra turns’ around the front foot. There is a point thought where a very tight band will apply so much pressure to the arm when it is pulled back, that either the band or the arm will snap
- You can fire any load but this does not mean you should fire ANYTHING. Small objects which are relatively innocuous when static may attain dangerous qualities when moving fast
- Repeated firing will gradually loosen parts in their slots, such as the feet. It is best to glue these in place before they get too loose
- ALWAYS get the students, and you, to use eye wear. Especially as if a load is unbalanced, not secure or angled over to one side of the arm, it may go sideways or even backwards at high speed..

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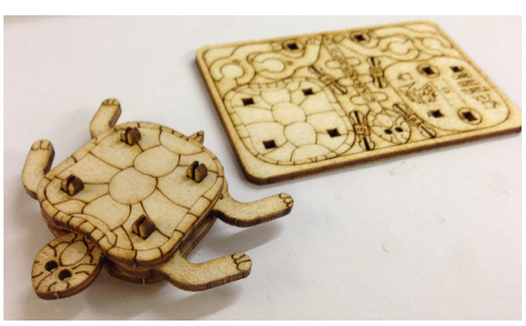
AJ Booker selling at the National UK Maker Faire in 2018

A variety of cam kits Coffee, Blank, Shark, Dog/Cat

A7 bicycle kit with lock and stand

Flexible Catapult kit that fires pennies



Mechanical moving turtle kit

As well as a range of educationally focused kits with free resources, I also sell a wide range of kits that cover many STEM areas. These are inexpensive, fun to assemble and will inspire people to take interest in the world around them.

I am available for staff training days, as a key speaker at your events and as an Educational Consultant to help you develop your STEM offering.