THE PULLEY

Name of the object	Pulley
Recommended ages (from…)	From 10 years old
Thematic areas combined (STEAM)	Science (Physics forces, Magnetism, Navigation) History
Materials needed	• Scissors • Precision knife • Cardboard paper • Tracing Compass • A thick Needle and 3 normal needles • Glue • Thread / thin cord (solid) (you will need at least a couple meters of thread) • Metal wire (at least 15 cm) • Wire cutter • 2 pincers • Old empty bottles (3) • 2 plastic cup that can hold several coins • At least 15 coins (same ones) • Straws (at least 2)
Instructions step by step	**Step 1**. Read all instructions carefully in order to understand the materials needed and the time needed. **Step 2.** Set up all the materials. **Step 3**. Prepare or create all components of the pulley system.

	Step 4. Assemble the pulley system with 1 pulley. **Step 5.** Assemble the pulley system with 2 pulleys. **Step 6.** Assemble the pulley system with 4 pulleys. **Step 7.** Draw conclusions.

Step by step: how to make a pulley system out of everyday objects

Step 1. Read the instructions

Time needed: 10 minutes

Read through the instructions carefully.

Step 2. Gather and set up the materials

Time needed: 10 minutes

Set all materials on a table and check that you have everything.

Checklist:

☐	Scissors
☐	Precision knife
☐	Cardboard paper
☐	Tracing Compass
☐	A thick needle and 3 normal pin needles

☐	Glue
☐	Thread / twine (solid) (you will need at least a couple meters of thread)
☐	Metal wire (at least 15 cm)
☐	Wire cutter
☐	2 pincers
☐	Old empty bottles (3)
☐	2 plastic cup that can hold several coins
☐	At least 15 coins (same ones)
☐	Straws (at least 2)

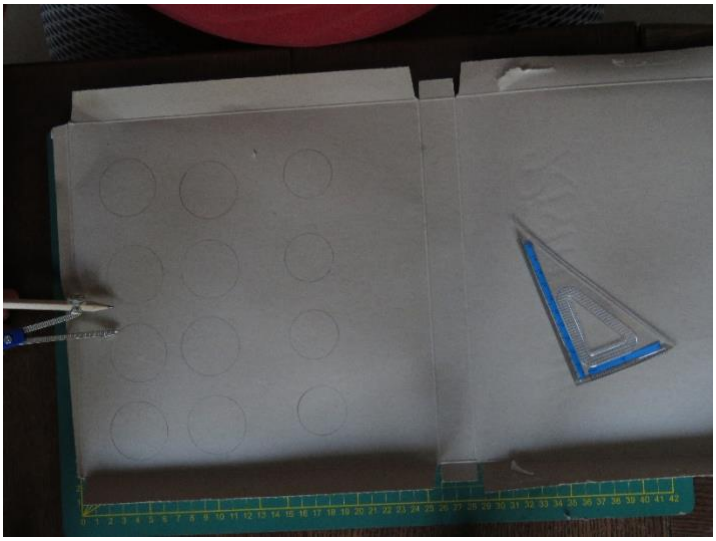
Prepare the materials.

Step 3. Prepare or create all components of the pulley system

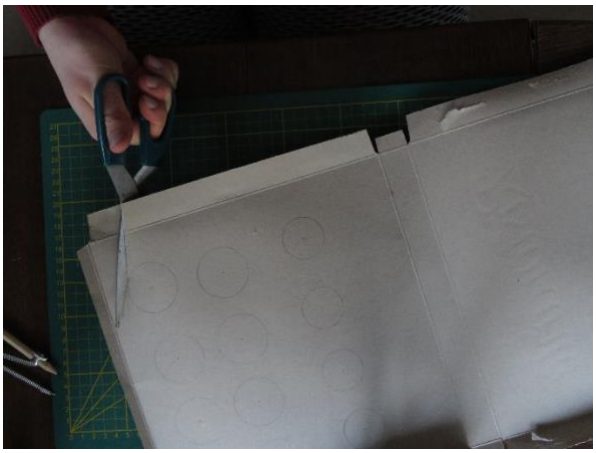
Time needed: 15 minutes

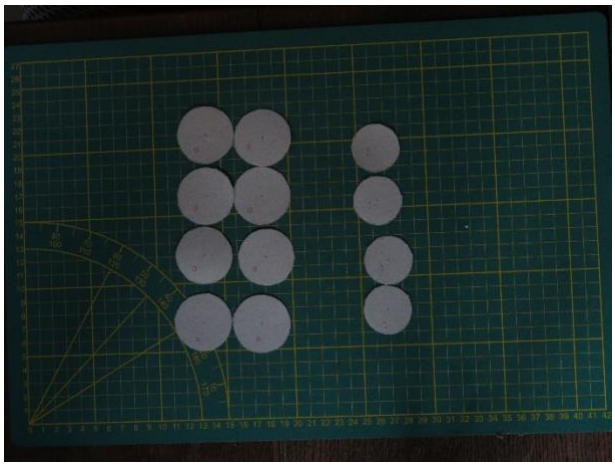
5 minutes:

With your compass, trace 8 circles with a diameter of 4cm, and 4 circles with a diameter of 3.6cm on your carboard paper, with enough space in between to cut them out properly later on (to make 4 pulleys). Take care to mark the centre of each circle. You can mark “O” on the 4cm circles and “I” on the 3.6cm circles to distinguish them more easily later.

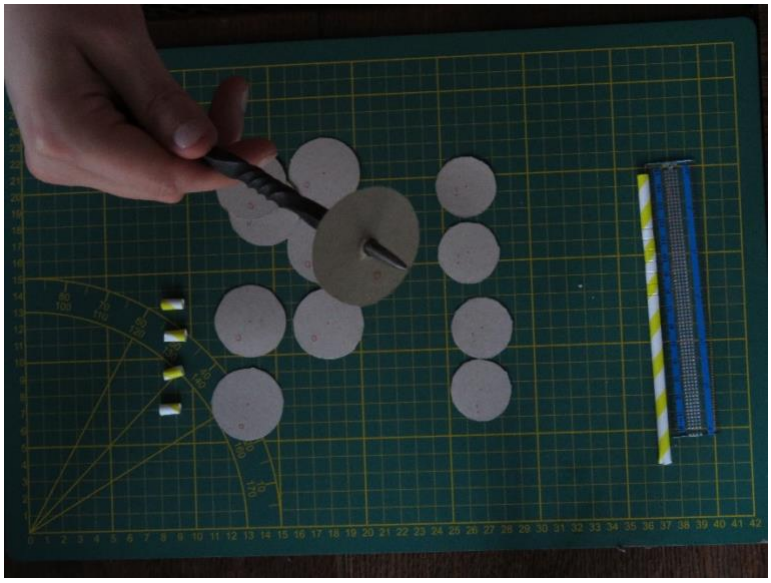


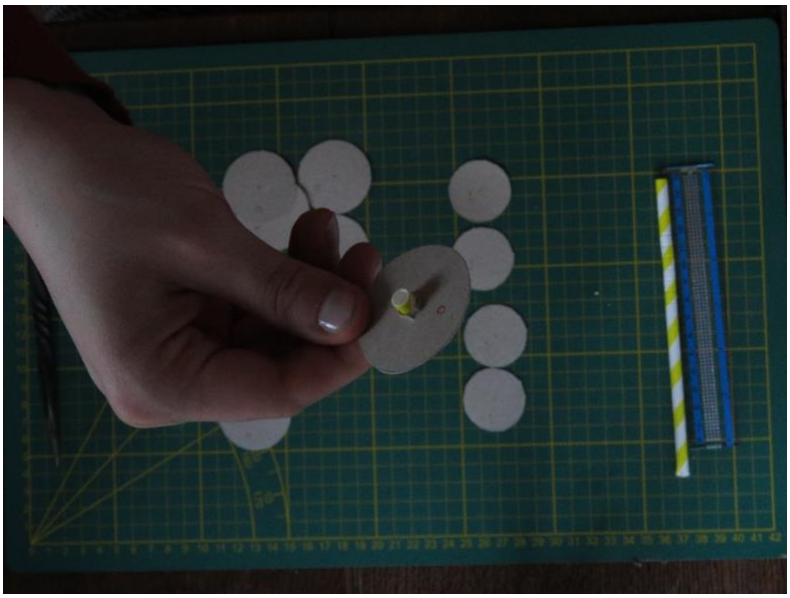
Once that is done, cut them out neatly. Each pulley will require 2 circles of 4cm diameter (O) and 1 circle of 3.6 cm diameter (I).



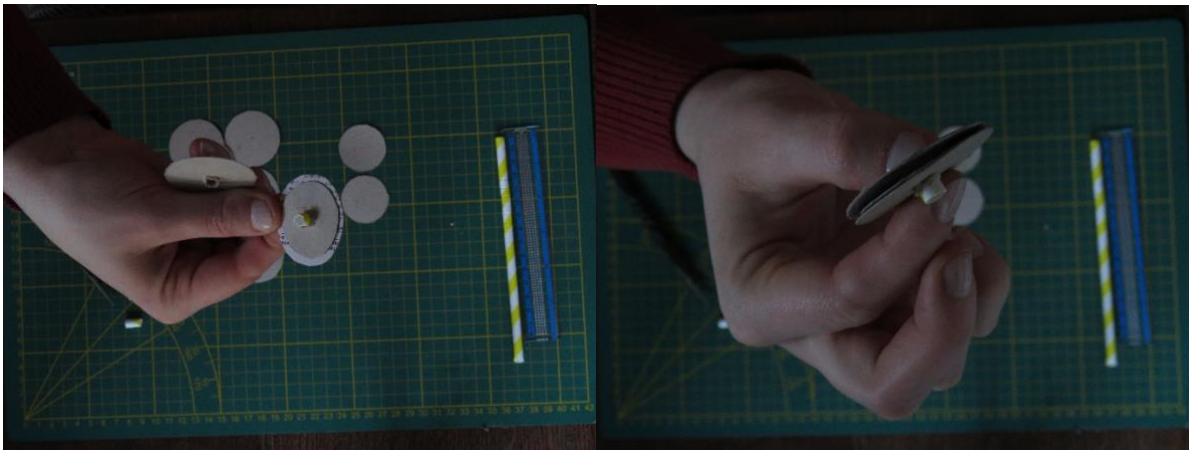


Once that is done, cut 1 cm of straw. Then, using a thick needle, punch a hole at the centre of each pulley so that the straws bits may fit through. Open the hole in the circles up until the straw can fit through.

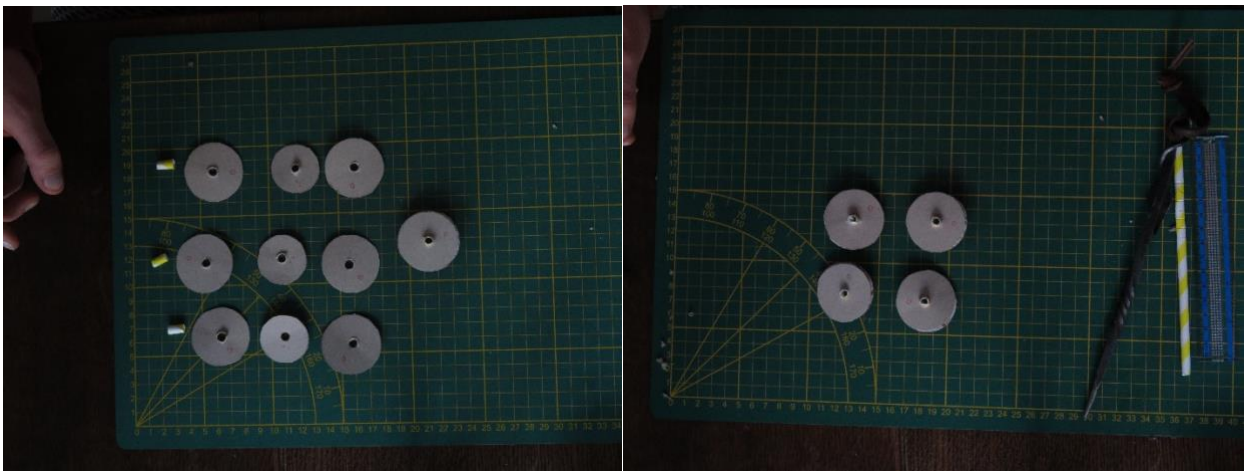




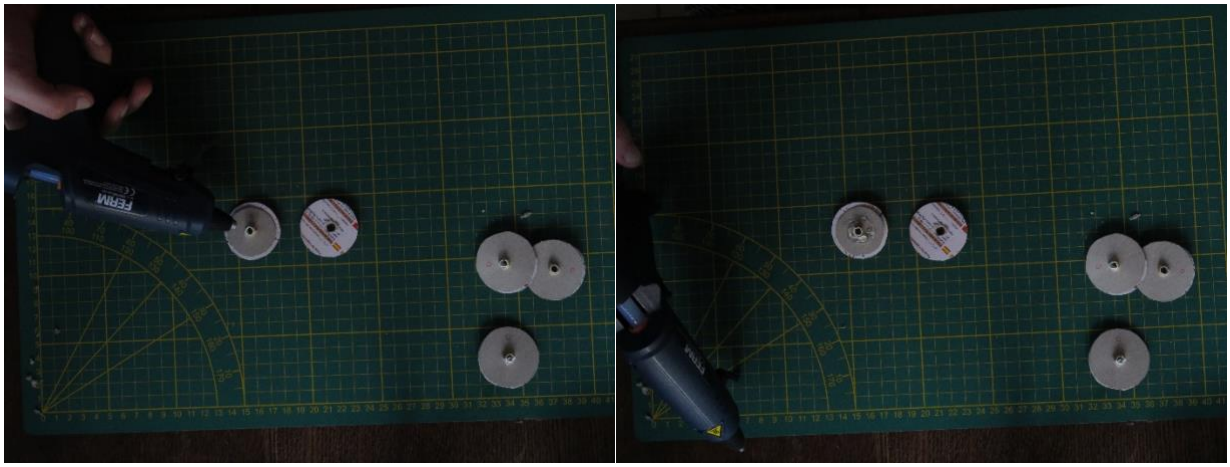
Put the 4 pulleys together. For one pulley, put one O circle first (outside), then take one of the I (inside) circles and add it to the previous circle, and end it with another O circle. (OIO)



Repeat the process 3 times in order to have 4 pulleys. We will use the 3 needles later on to act as either axels for the pulleys that are fixed to the top of the bottles (2) or to attach the beginning of the thread on the top of the first bottle (1)



Once you are sure that everything fits correctly, glue the pieces of the pulleys together. Here we use hot glue, but you may use simple glue as well. As we explained, the pulleys need to follow a “OIO” (outside circle, inside circle, outside circle: the smallest circle between two bigger ones) glued together, with a 1 cm straw going through them.



Use the bottles as stands, you will need three bottles with needles stuck to the top. You may heat the needles up with a lighter before sticking them into the bottle to ease the process.

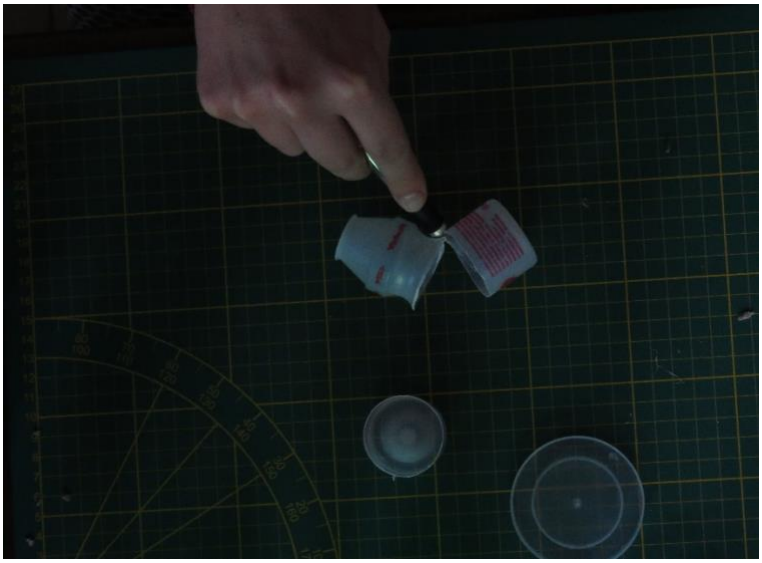
Step 4. Assemble the pulley system with 1 pulley

Time needed: 10 minutes

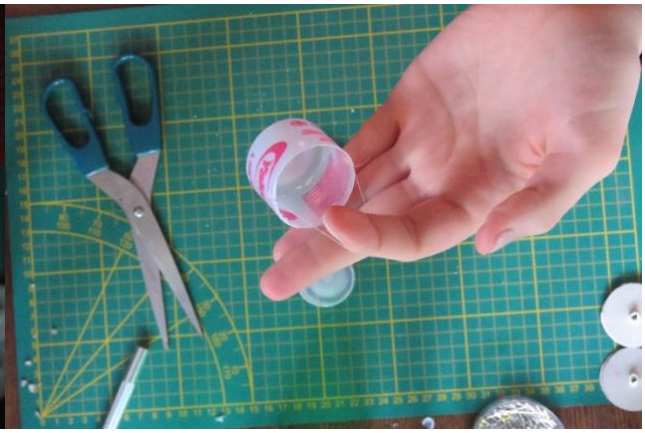
Set one bottle up to fix the pulley at the top on the button.

Take one of the needles, thread a piece of straw sideways (it will serve as a stopper to prevent the pulley from falling off the needle), then thread the pulley through its straw, and then you may put another piece of straw sideways for more stability, then punch the axel needle into the bottle top.

Prepare one of the small containers with coins inside as weight. Here we use empty Yakult (yoghurt) bottles to create it. Cut out a bucket-like shape.

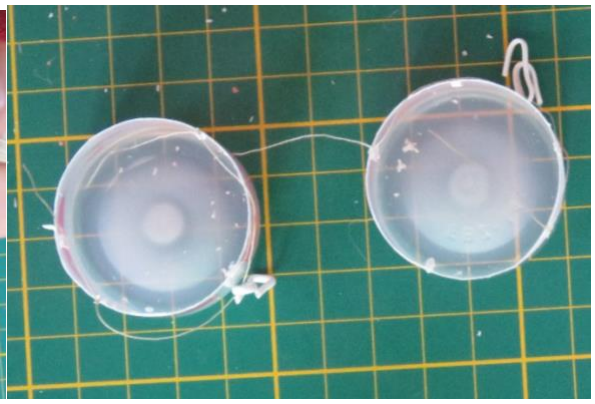


Punch two holes facing each other on the sides of the container to thread some twine and make a handle (like a bucket).

With the wire, cut a small piece (about 1.5cm) and create a hook to hook your makeshift bucket to the twine handle. Fix the hook on the handle of your bucket.


Repeat the process a second time to have 2 “hookable” small buckets of coins.

Take a water bottle to use as a stand. You may keep the bottle full to have weight and prevent it from toppling over easily.

As we explained above, on the axel needle, thread a small piece of straw sideways to act as a stopper and prevent your pulley from sliding until it touches the bottle. Then add the pulley by putting it on the needle (through the straw part of your pulley) and thread another piece of straw sideways to act as a stopper on the other side of the pulley.

Measure the height of the bottle, and cut twine or thread of this length approximately: length of the bottle + 5 cm

Make a small loop on one side where the hook of the bucket will come and pass the length of twine up and around the pulley so that it comes back down on the other side.

Pull the twine towards the ground and lift the bucket.

To lift the bucket without the pulley you would need a strength of X (depending on the weight of your coins)

With the pulley, you will need that strength minus the gravity.

Step 5. Assemble the pulley system with 2 pulleys

Time needed: 10 minutes

You may add a second pulley like so: by adding a second bottle, attaching one end of the twine, hooking your second bucket directly to a pulley, threading the twine underneath this pulley, then above the first pulley. You will need slightly over half of the weight of the bucket down to lift it up. You thus divide the strength needed to lift the

bucket by half of what it would have been if you simply lifted it without pulleys. To lift a bucket of 10 coins, you will need 6 (slightly more than 5)

Step 6. Assemble the pulley system with 4 pulleys

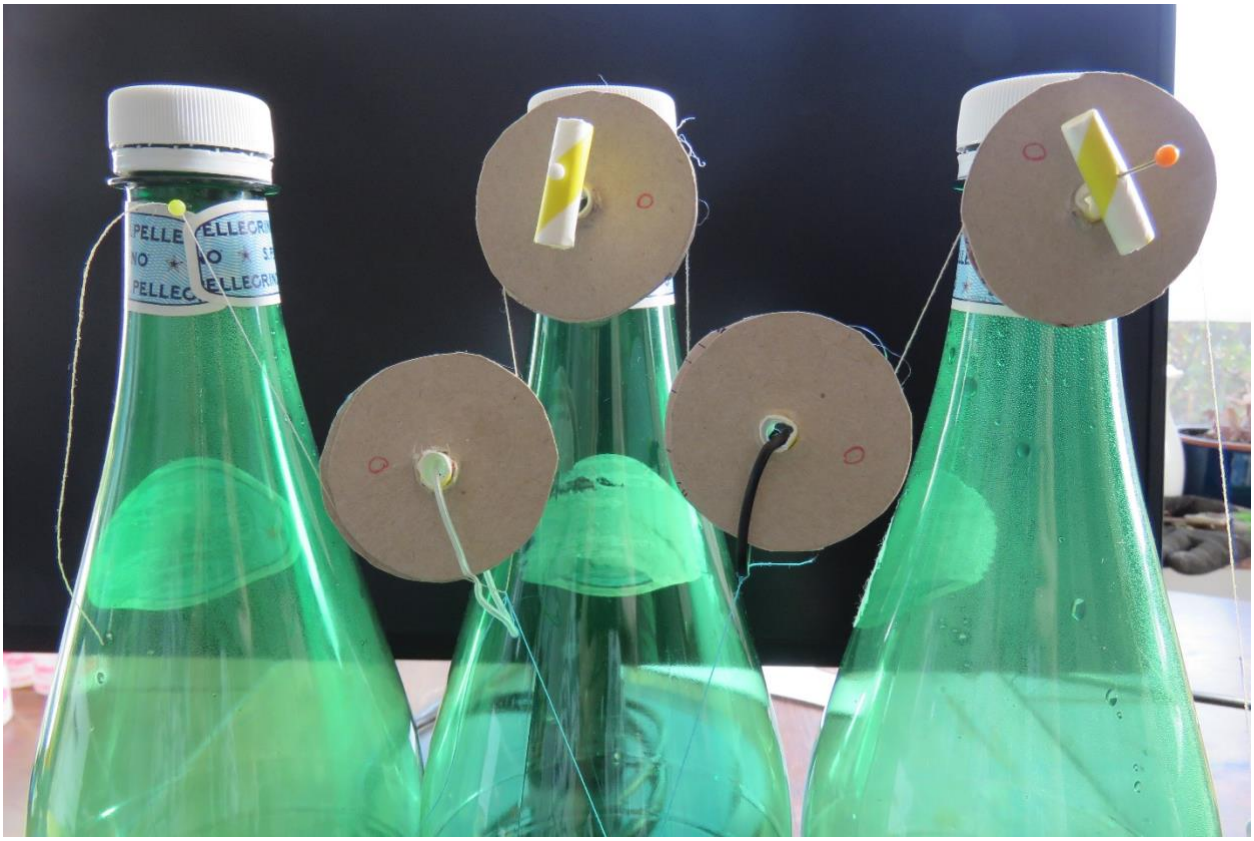
Time needed: 10 minutes

For this step you will need 3 bottles. You attach the twine to the top of the first bottle and thread the twine down under a first pulley (attached to the weighted bucket to lift), then up over a pulley attached on the top of the second bottle, then back down under a

third pulley that is also attached to the bucket to lift, and finally, back over the pulley attached to the third bottle. To this other end of the twine, you also attach a bucket. (We will call it bucket 2.)

To lift 10 coins, you will need to insert 4 coins (a little more than 3 coins).

As you can see, you need to add a piece of wire inside both downwards pulleys and link them with a piece of thread, on which you will hang the bucket.



Step 7. Draw conclusions

Time needed: 10 minutes

Play around with the number of pulleys and the weight to find out by how much the weight is divided with each additional pulley. You can also double the pulleys on a single stand.

Let the pupils experiment and take note of their results. Then go over the theory with them to illustrate exactly what happens on a physics level.

Additional content:

- EN : Simple Machines: The Pulley

https://www.youtube.com/watch?v=r3Ru1zZjvug

- EN : Why Snatch Blocks are AWESOME (How Pulleys Work) - Smarter Every Day 228

https://www.youtube.com/watch?v=M2w3NZzPwOM

- DYI Pulleys with everyday things

https://www.youtube.com/watch?v=TG7MK3L2LFY