

THE FIRE PUMP OF KTESIBIOS AND HERON

Name of the object	The fire pump of Ktesibios and Heron (simple tools)
Recommended ages (from...)	From 12 years old
Thematic areas combined (STEAM)	Science (Physic forces, Pressure, Materials) Engineering Mathematics (Measurements) History
Materials needed	A drill A cutter/precision knife A glue-gun Three cans Two wooden rods Two bases for the pistons (here, the cans' plastic caps) Four laminated papers/drawing paper protected with plastic tape Three pieces of water hose/ plastic straws <u>Optional materials:</u> Two pieces of wood (about 50cm long) to make the lever Two screws (shear bolts), washers and nuts for screws A hammer A nail

Instructions step by step

Step 1: Setting up all the materials and looking at the instructions and models.

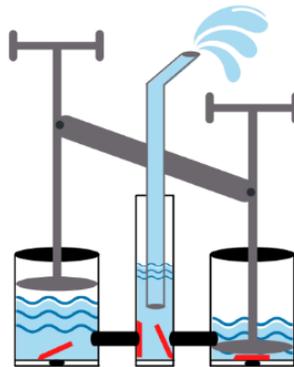
Step 2: Creating the pistons

Step 3: Building the middle can (tube)

Step 4: Connecting the pistons to the central can

Step 5: Additional step: final touches (optional)

The fire pump of Ktesibios and Heron

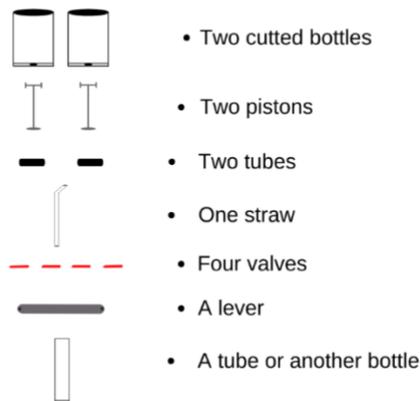


Step by step: how to build the fire pump by using simple tools

Step 1. Setting up all the materials and looking at the instructions and models

Time needed: 5-10 minutes

Parts of the fire pump



First, prepare the materials.

Disclaimer: Power tools should be handled by the educator, or under very careful supervision of the educator if they deem the students capable of handling it. They are dangerous tools to handle. The same is true for the glue gun and the precision knife.

Step 2. Creating the pistons

Time needed: 50-60 minutes

Cut the upper part of two of the cans to create buckets as a basis for the pistons. In this case, we used empty coffee cans with a plastic cap. The cap can be cut to internal size easily, is rigid enough to act as the inside of the piston, and flexible enough to enter the

piston without losing its shape. The caps will be used as a basis for the inside of the piston.



The two cans in which the pistons will be placed need one hole each, at the bottom. Take the drill and drill a hole in the centre of the bottom of the two cans. This hole will provide the bucket with water. Be careful, as using cans may require the holes to be drilled before-hand. In which case, this step should be prepared by the teacher only.

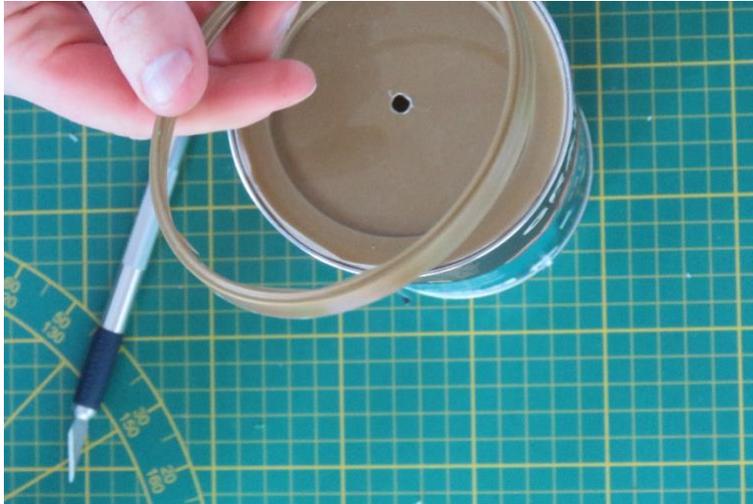


Each bucket needs one more hole, to the side, near the bottom of the can. This hole needs to have a diameter equal to the diameter of the water hose/plastic straw you will use as a link between the pistons and the central tube (can). This is where the hose will be attached to connect the piston cans to the tube can.



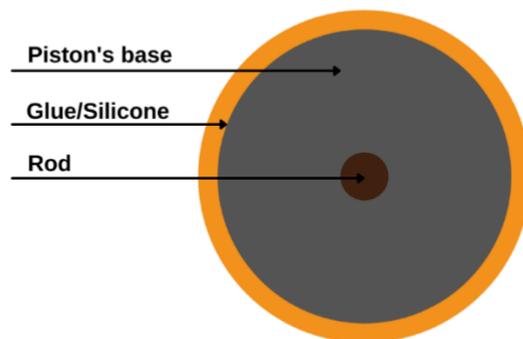
For the pistons we must have round bases with diameters equal to the can's diameter. Here, we decided to use the plastic caps. We took a precision knife and removed the small excess that goes beyond the cap in order to create a piston base of the same diameter as the can. We also pre-drilled a hole in the centre of the cap where the rod will enter.





To improve the pistons' power, use the glue gun. Apply a small amount of glue on each base around the perimeter. We must leave the glue to dry.

The result should close up any gaps between the base of the pistons and the cans.



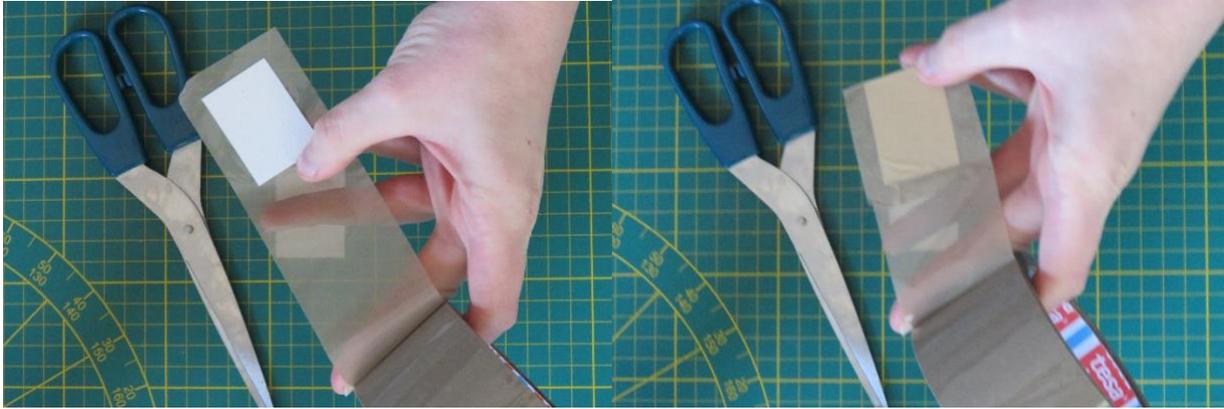
For the rods, we decided to use reclaimed chopsticks.



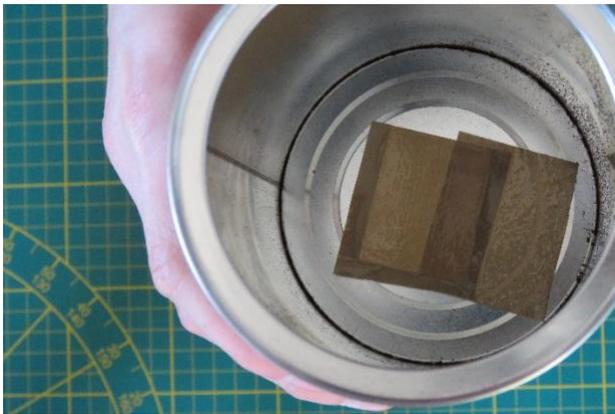
We checked that the pistons would work, then used the glue gun to fix the rods to the piston bases. Use the glue gun on both sides.



To make the bottom valves of the pistons, cut two square pieces of paper (roughly 3 cm/3cm) and waterproof them by wrapping them in plastic tape.



Then, take some more tape and tape the side of it to the inside bottom of each can in a way that it will flap on top of the hole with the water flowing.



Step 3. Building the middle can (tube)

Time needed: 10-20 minutes

For the central tube, we will use a third coffee can. It needs two holes on opposite sides, where it will be connected to the buckets by hoses. Likewise, as with the first two cans, the holes need to be the same diameter as the straw/hose piece you will use, and near the bottom of the can, at the same height as the other holes you made. Take your drill and drill both holes.



For this central can, you will need to add two valves inside to cover the two holes on the sides. As it is a round surface, here we only used plastic tape as a valve material. Take some tape and fold it on itself (sticky sides in) to create a “non-sticky plastic surface”. Then cut it a couple of centimetres higher. Once that is done, cut it in half in order to have two valves.



Stick those valves inside the central can to cover the holes on the sides up.



Take the cap of the central can, keep it whole but drill a hole of the diameter of the straw/hose in the centre of the can. Then, using the glue gun, fix the straw/hose that will be used to project water (it needs to have at least the size of a full plastic straw)



Step 4. Connecting the pistons to the central can

Time needed: 15 minutes

Take a plastic straw and cut it in half or take 5 cm of hose twice. Connect each piece of straw/hose to the two holes on either side of the central can, and seal them with the glue gun.



Here we used paper straws to show you the process, but as they will be filled with water and submerged, we would advise against using paper straws, as they are not very water resistant in the long run.

Once the straws are connected to the central can, repeat the process with the two other cans to connect all of them together.



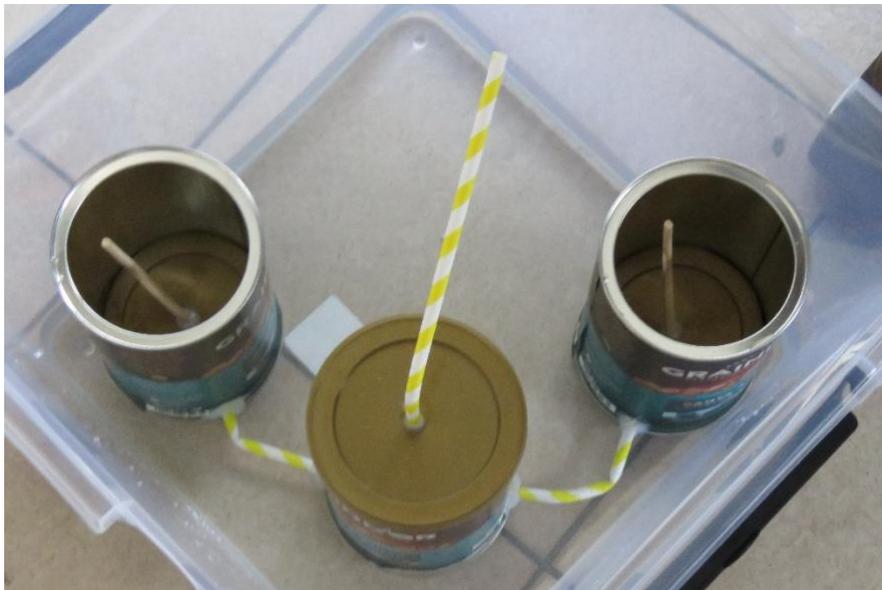
Be careful to make every linking part watertight with the glue gun.

At this point you may test your pump to see if the valves work. Make sure that the paper allows the water to flow out, but does not allow it to flow back in. To do so, you can experiment with air flow first. Blow some air into the valves and see if the air flows the way it should.

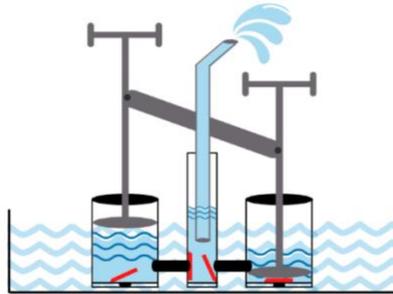
Next, you will want to test if water flows correctly. Take a big bucket (the whole contraption must fit in comfortably) and fill it with about 5 cm of water. It can be more but not higher than the top of the cans. We recommend filling the bucket only until the middle of the device with water. Then put your pump in the water. Test the pistons out with the central bucket's top cap opened to see if the water flows in and if the valves do their job properly. If it doesn't work, empty and dry everything and make sure everything is as watertight as possible before trying again.



Once it is done, attach the cap on the central can and make the pupils pump each piston in alternation.



Now you can use your fire pump!



Step 5. Additional step: final touches (optional)

Time needed: 10 minutes

When the pistons are ready, you may connect each piston's rod together with a long horizontal piece of wood which will be the lever.

Drill two holes at each end of the lever (same distance as exists between the rods).

Also, drill one hole on each rod's top end. Attach each rod to each side of the lever by using the screws. In between the nuts, use washers.

Additional content:

- Youtube video of the firepump in action:
<https://www.youtube.com/watch?v=d5jAyl3piSE>
- Another Youtube explanation of the water pump in action: (EN)
https://www.youtube.com/watch?v=HL1JA_EUYpY