BICYCLE-POWERED RAIN BARREL PUMP

JRGBC Connect the Dots Green Schools Challenge 2013

St. Catherine's School » Tim Harper Design

1. The Rain Barrel
2. The Bicycle Stand
3. The pump

1. The Rain Barrel

For our project we reused a standard 55 gallon drum that had been a container for floor wax.

These drums generally come with two holes in the top to pump out the liquid; however, too make it a usable rain barrel, you need to cut the top off completely. We found a great clip on YouTube that shows where to cut in order to reuse the lid **(http://www.youtube.com/watch?v=-oJRRyqjkDs)**.

As the video shows, a few inches from the top the barrel is beveled to its narrowest point. If you cut the lid off completely at as shown (I used a basic hand rip saw), you can flip it over and it fits nicely over top.

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We used a 1" plastic ball valve for our nozzle; that's bigger than your standard garden hose attachment, but for our pump it fit perfectly (and allows a lot more water to flow, as a standard garden hose fitting is only 3/8").

The ball valve has screw threads on the back end, so after drilling a hole we were able to connect it to a plastic nut and tighten it down. Our local hardware store didn't have this size washer, so I used a combination of a 1" O-ring and homemade washers cut out of flat rubber, then sealed with silicone to keep the connection water tight.

We used a 1" washing machine-type hose to connect the valve and our pump, with a steel hose repair clamp added for good measure.

Inside the barrel we fastened a piece of fine mesh overtop of the outflow valve to keep debris from flowing into the pump.

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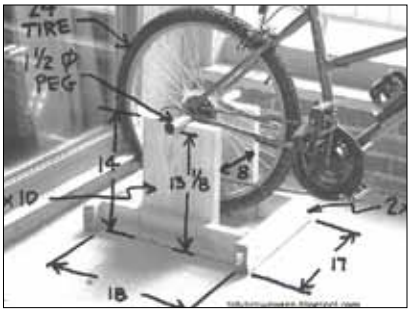
2. The Bicycle Stand
Ideally for the bicycle stand, you can buy or find someone to donate an indoor bicycle trainer like the one shown here.

If you are on a budget (as we were), you can build your own out of scrap wood. We found our version on a blog called 'Tidy Brown Wren' (**http://tidybrownwren.blogspot.com/2013/01/plans-for-diy-exercise-bike-stand.html**). Their measurements worked perfectly, although in the end we added some reinforcement to withstand the rigors of being ridden by fourth graders.



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3. The Pump

Design and construction of your DIY rain barrel pump depends on the type of pump you can procure:

Piston Pump

There are quite a few examples on YouTube of bike pumps using pistons, such as the photo to the right of a University mechanical engineering project (**http://www.youtube.com/watch?v=BtObp4IlIaw**). We wanted to try a rotary pump first, as it seemed simpler to stick with the rotary motion of the bike wheel rather than trying to translate rotary into linear movement.

Piston Pump

Self-priming Impeller Pump

There is a great example of a bike-powered rain barrel pump on **harvesth2o.com**, using the marine pump shown to the right here (**http://www.harvesth2o.com/Pedaling_Bicycle_pump_disclosure.pdf**). Had our budget been higher, we may have used this design (and a prefab bike trainer)—however, these pumps retail in the range of $230-$300, well beyond our means for this project.

Self-priming Impeller Pump

Drill Pump

Found some examples of successful use of this pump on YouTube; however our experience was that they are very cheaply made and not worth the effort.

Drill Pump

Rotary Drum Pump

We used a plastic Rotary Drum Barrel Pump shown to the right, $36 from Amazon. Much sturdier than a drill pump and much cheaper than the marine impeller pump.

Rotary Drum Pump

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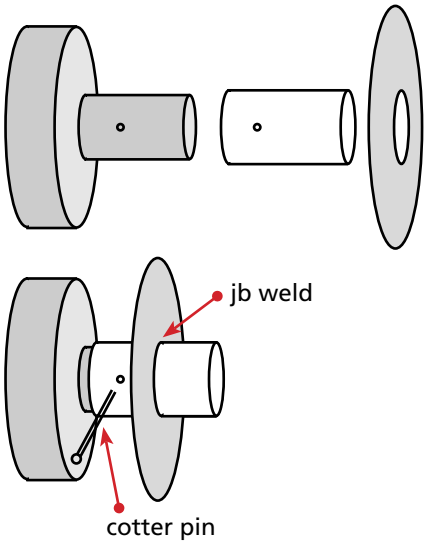
3. The Pump: attaching the gear

We took off the handle and attached an old bicycle gear in place to drive the pump. Securing the gear was tricky. We found a metal cylinder (part of an old bike frame) slightly larger than the pump shaft, and drilled a hole through it and the pump shaft itself. After securing the gear to the metal cylinder with J.B. Weld, we attached the cylinder to the plastic shaft of the pump with a cotter pin.



X 3.5 inch gear: too small!

√ 7 inch gear: much better!

Note: the size of the gear matters!

We assumed the gear would turn the pump as easily as the handle did. Wrong! With our first gear it was so much harder, that pedaling the bike would twist the pump around until the chain fell off and the gear nearly snapped off the pump shaft.

What happened? The radius of the gear (the moment arm) was much smaller than the length of the handle, which meant it was taking much more force to create enough torque to rotate the pump, or so goes my layman's understanding of physics. The important part is that switching to a much larger gear (7" diameter, from an old dirt-bike) solved the problem.

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3. The Pump: Vertical vs. Horizontal
The pump was designed to screw into the top of a 55 gallon drum and suction water up and out.

The pull of the bicycle chain caused the pump to wobble and pop the chain; additionally, it took a lot of pedaling to pull the water up out of the barrel.

In the end, we switched to a horizontal pump, with a valve fastened to the bottom of the barrel. This gave us the ability to build a solid structure to keep the pump from moving, and gave us added water pressure without having to pump the water up first.

We built a second structure to hold the pump, replacing some of the bolts on the pump body with longer bolts attached to a wooden support. We added a shorter wooden support piece for the drive-shaft. The pvc piping you see is not attached — the drive shaft turns loosely within, and the pvc keeps the pump from wobbling back and forth.

The purple bike axle you see below was added to help support the tubing into the pump, which moves a good bit when you are pedaling (the smaller wheel on the axle has no function, it was just added for fun).

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So we have two structures — the bike stand and the pump stand. We found it better not to attach the two. You need some wiggle room to move the structures apart, giving the bike chain more tension (hence the wooden shim here).

Attaching the hose from the barrel to the pump shaft took a little hacking, because the screw threads on the pump body and tubes are not the same as standard plumbing materials. We eventually found a brass fitting roughly equal in size to the plastic pump tube, and with a little Goop glue and teflon tape were able to make a fitting that would fit the black hose.

The other end (where the water flows out of the pump) was much easier. A spare bit of the same black washing machine hose fit nicely on the end of the nozzle that came with the pump; in the other end we glued a garden hose attachment similar to the one shown below.

X Bell $5 cheapo chain tool: a piece of junk.

√ Park Tool CT-3

Links:

Cutting the top of a 55 gallon drum:
(http://www.youtube.com/watch?v=-oJRRyqjkDs)

DIY stationary bike stand:
http://tidybrownwren.blogspot.com/2013/01/plans-for-diy-exercise-bike-stand.html

Rain Barrel with Piston Pump:
http://tidybrownwren.blogspot.com/2013/01/plans-for-diy-exercise-bike-stand.html

Rain Barrel with Impeller Pump:
http://www.harvesth2o.com/Pedaling_Bicycle_pump_disclosure.pdf

Our Pump in Action:
http://youtu.be/ja_C0tpErSQ

More YouTube Pumps:
http://www.youtube.com/playlist?list=PL2xVI4hOgfIQuzQnCbrDY3-f0uiJyyYk0