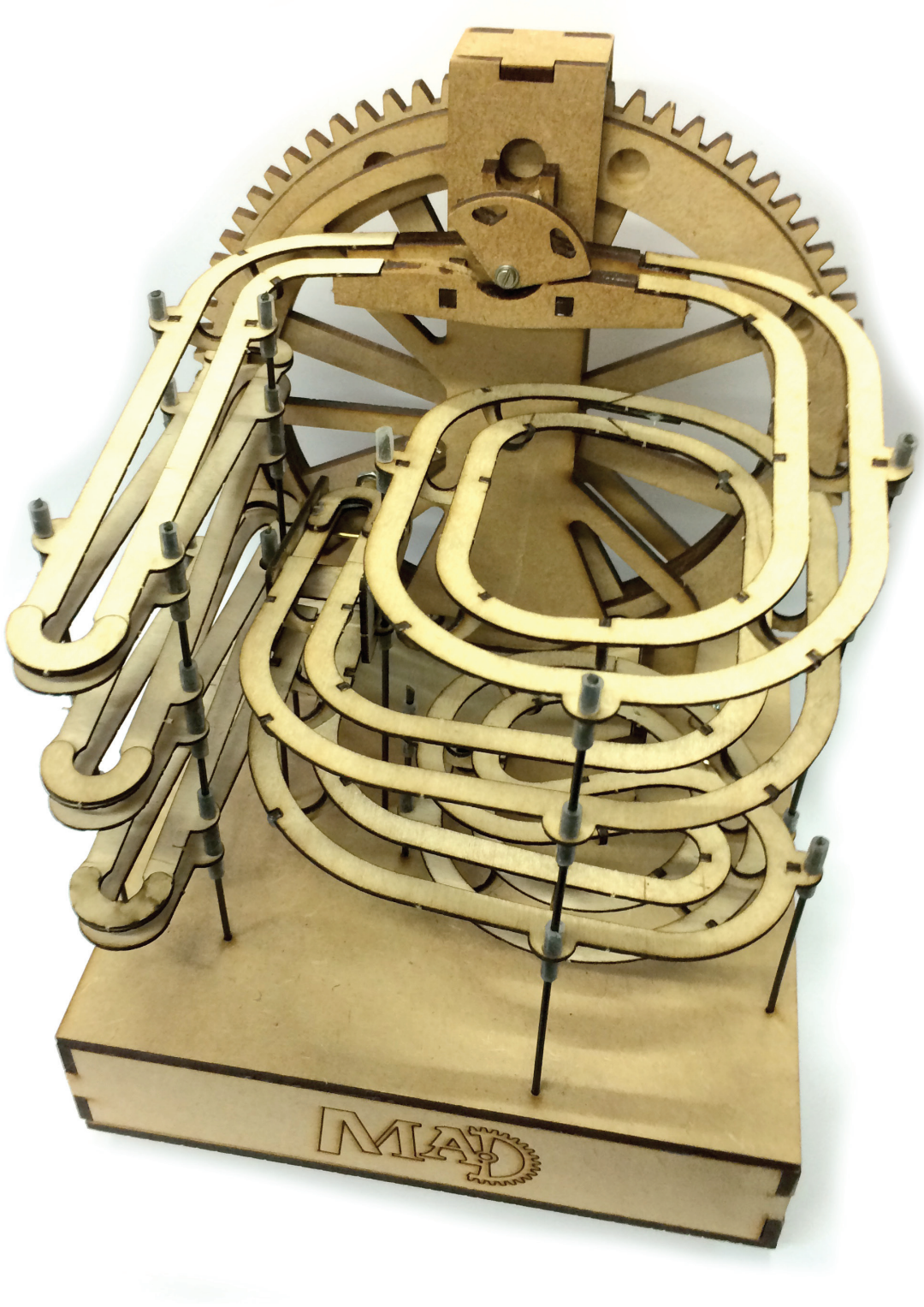
MECHANICAL ART & DESIGN museum

DESIGNED BY
BUSTED BRICKS
ENGINEERING & ART

Assembly Instructions for Marble Machine #2



Ver. 3

Assembly Instructions for MAD Marble Machine #2

Required for assembly:

Wood glue (PVA or aliphatic resin recommended)
Clamps or weights, strong rubber bands
Sharp hobby knife
Small flat head screw driver, small Philips screwdriver
Varnish of your choice (not essential but recommended)

A ruler for measuring the carbon rods is included with the kit.

A few building tips before you get started

Most parts will have some small pips on the edges. These are from the tabs used to retain the parts in the sheet while it is being laser cut. Sand the pips off before starting assembly.

It is recommended that you assemble the kit with a good quality wood glue, either PVA or aliphatic resin. Titebond is good, I sell that in the shop and use it a lot myself. Some parts require sparse application of glue and this is best done with a small paint brush or a toothpick. Thin the glue a little bit with water and use the brush to apply it. Note that the cut edges of MDF can soak up quite a bit of glue.

It is recommended that you varnish the MDF and plywood to protect the surface. There is a large selection of water or solvent based coatings available. My preference is to use a semi-gloss polyurethane varnish thinned a bit with white spirit. If you want to colour the MDF and ply you can use wood dyes. Dye has the advantage that glue still adheres well to the parts after dye has been applied. If you decide to paint the MDF it will have to be sealed first. You can buy dedicated water based MDF sealer or use grey automotive primer from a spray can.

You will invariably drop some steel balls on the floor. DO NOT use a magnet to pick them up. If the balls get magnetized they will stick together and it might prevent the marble lifter from working correctly.

It is a good idea to dry assemble parts using the pictures in the instructions as a reference. Ensure you know what goes where BEFORE applying glue. Wood glue gives you ample working time and glue applied in the wrong place can be wiped off with a damp rag.

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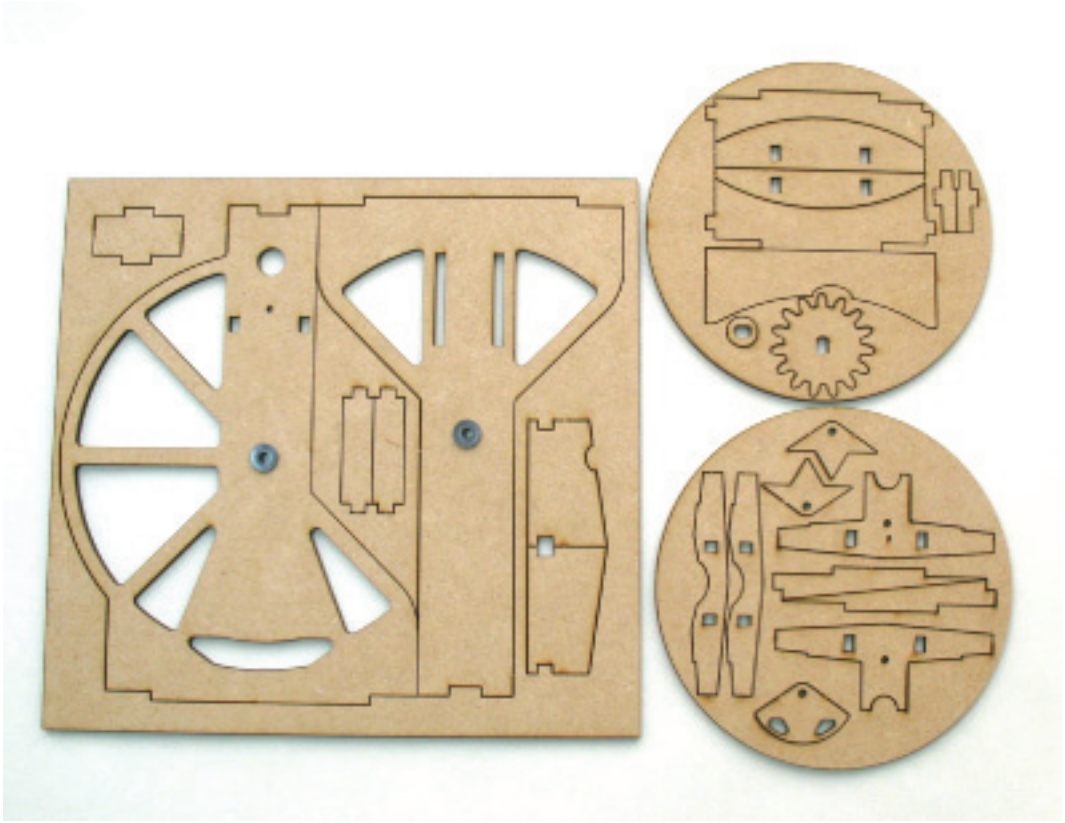
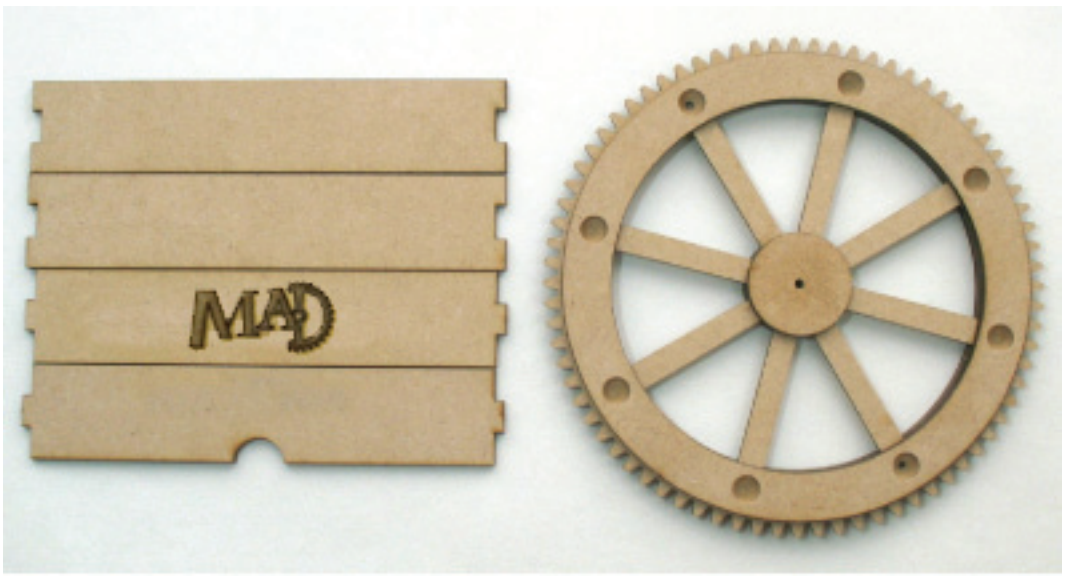
Kit contents





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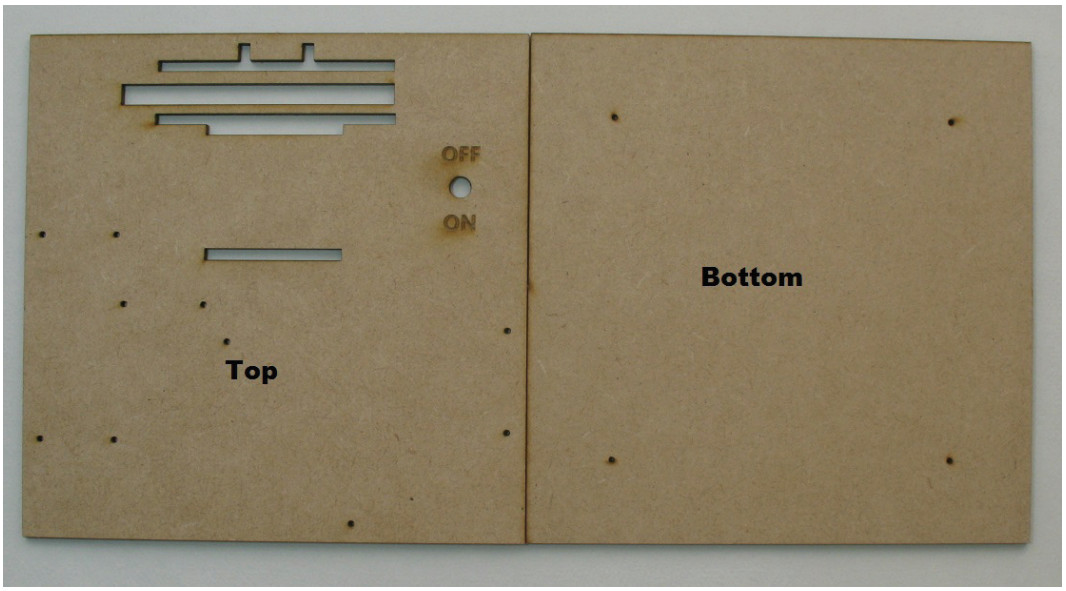

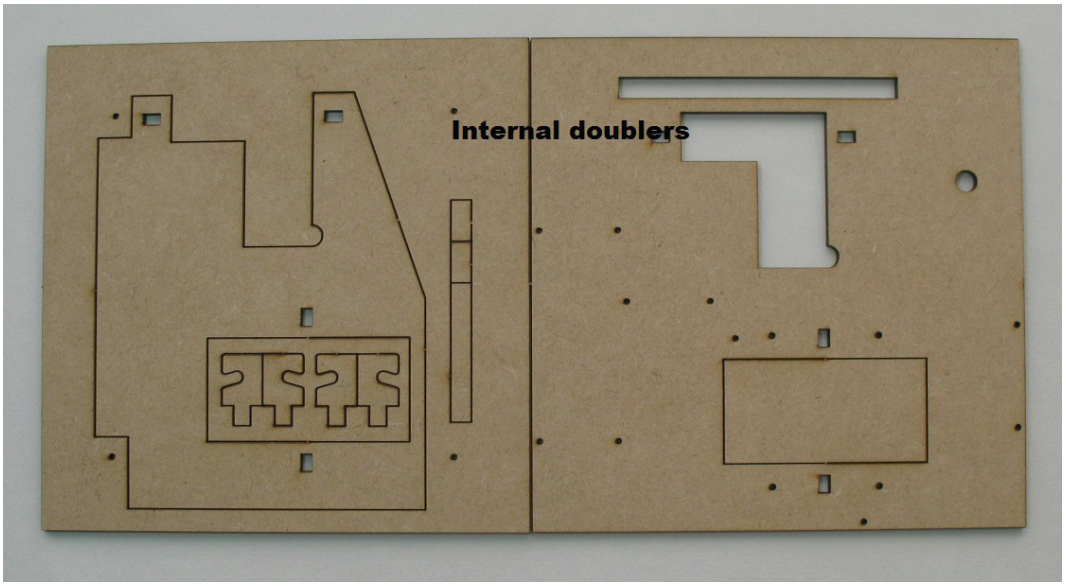

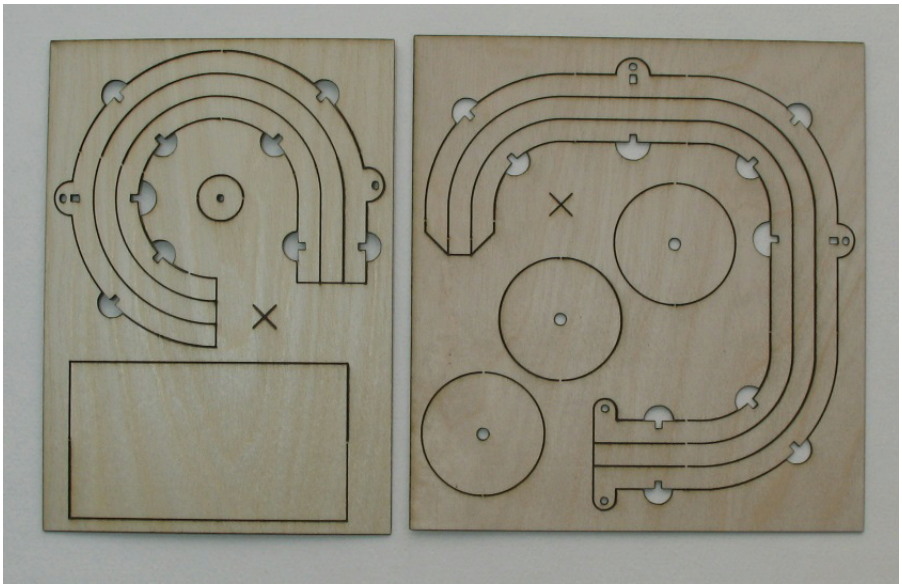

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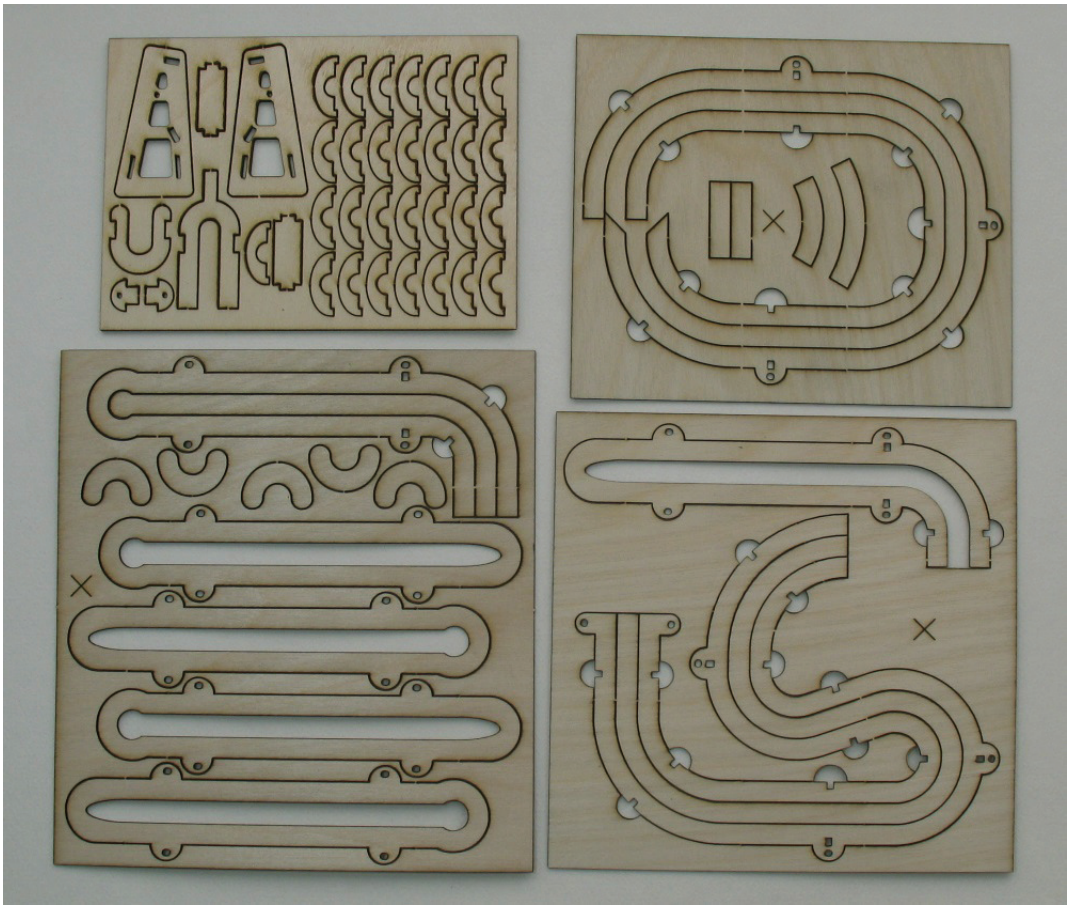
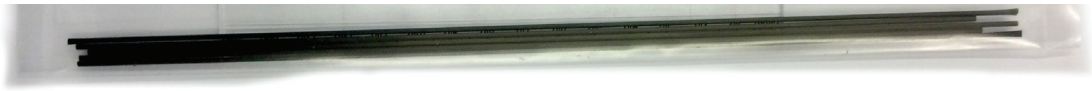
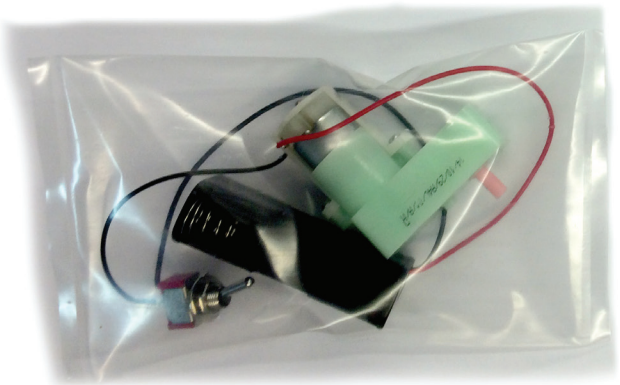


Included accessories:





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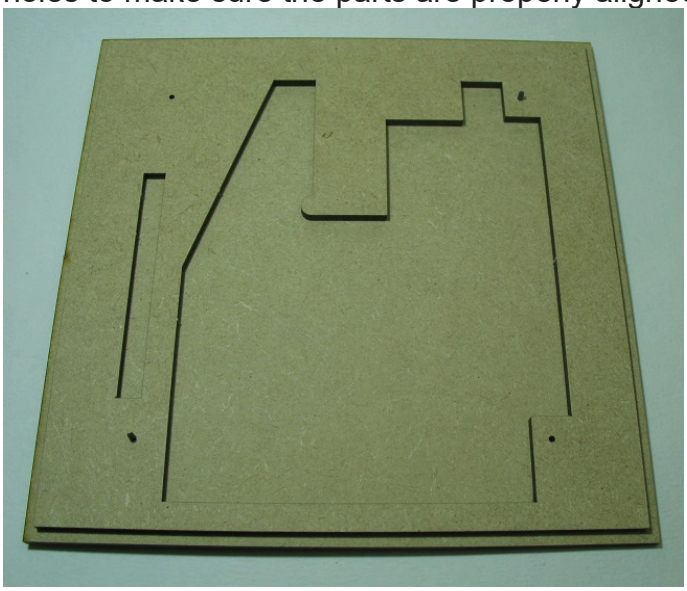
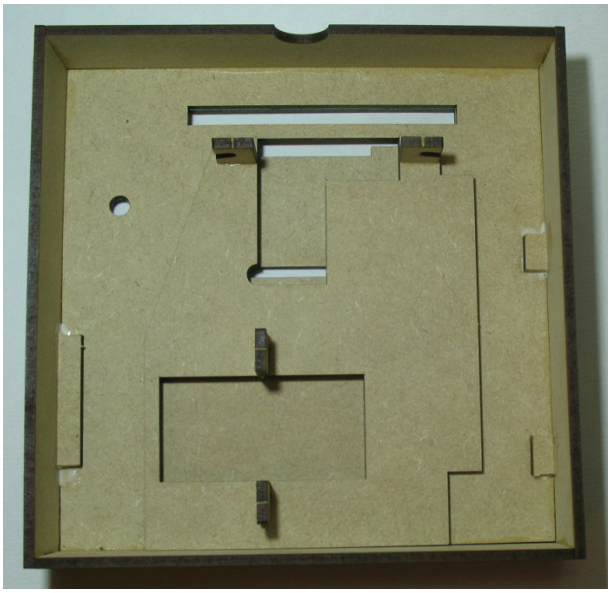
Base

Glue the bottom and doubler pieces together. Use a couple of short lengths of carbon rod in the holes to make sure the parts are properly aligned.

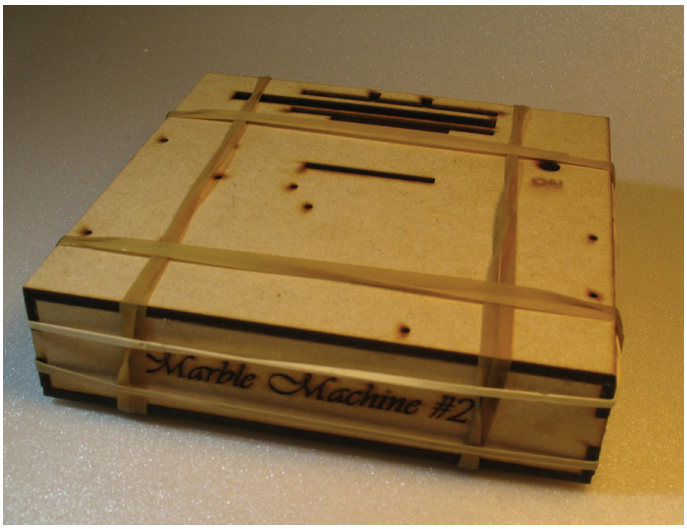


The top part of the base consists of three pieces. Glue the top and doubler together, using short pieces of carbon rod for alignment as with the bottom. Add the motor/battery retaining part. The rubber band hooks take care of the alignment. Cover the 1.5mm holes with the small MDF pieces supplied.

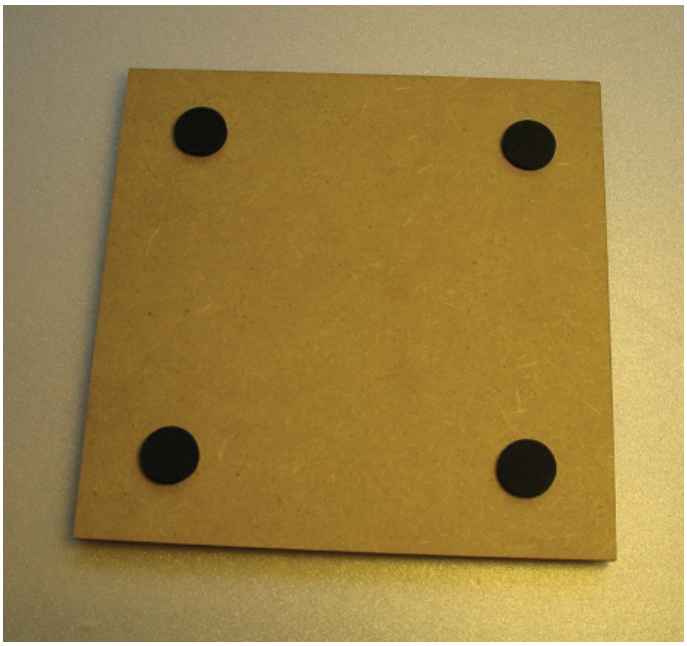


Glue the side pieces together and onto the top piece. The bottom piece should NOT be glued as it must be removable for access to motor and batteries. However it can be used to keep the base parts aligned while the glue dries. Hold the parts together with strong rubber bands.

Assembly Instructions for MAD Marble Machine #2



Stick the self-adhesive foam pads to the underside of the base.



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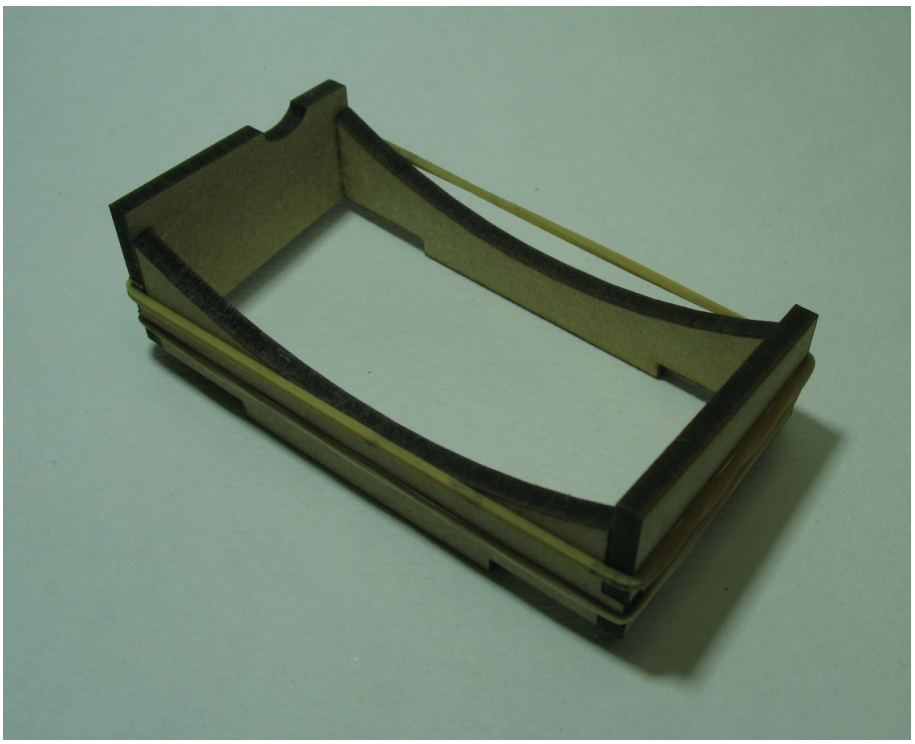
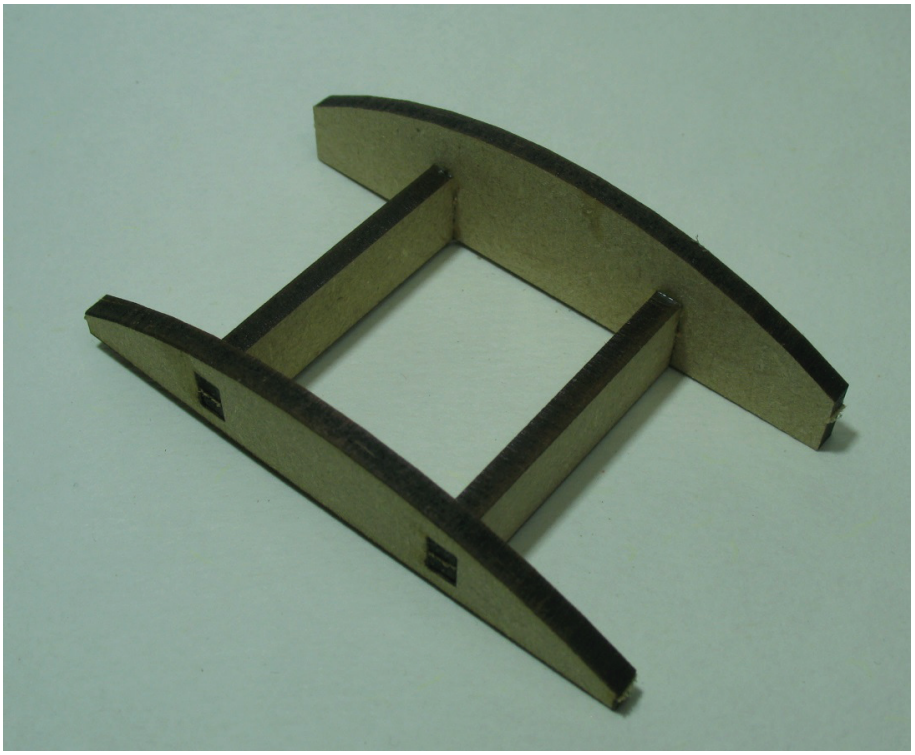
Ball Tray

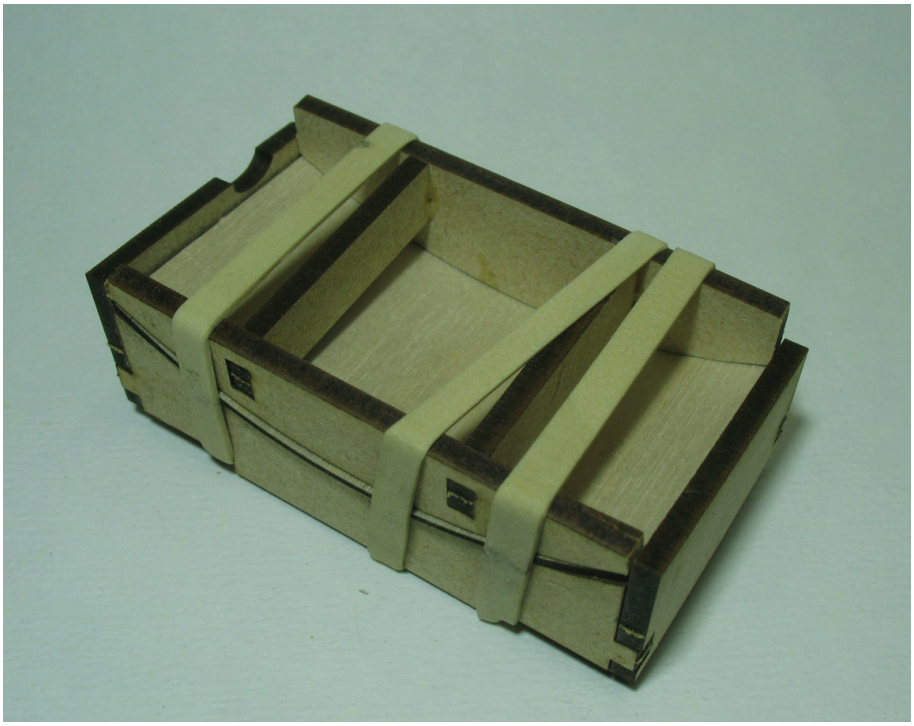
Glue the ball tray MDF parts and the clamping aid together as shown in the pictures. The ball tray can be inserted into the base top to hold the pieces aligned while the glue dries. DO NOT glue the tray onto the base yet. The tray side with the cut-out should face left when the machine is viewed from the front.



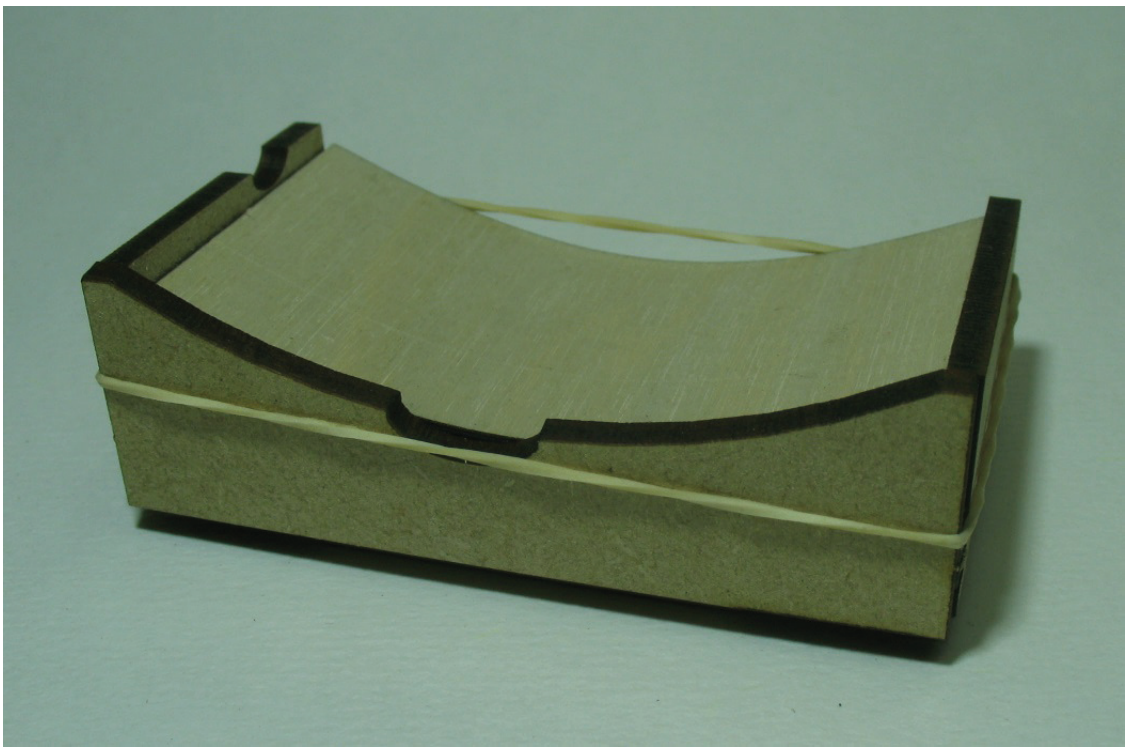


Assembly Instructions for MAD Marble Machine #2

When the glue is dry you can glue the ply top in place. Be generous with the glue as the cut edge of the MDF will soak up quite a bit. Use the clamping aid to press the ply firmly against the tray base and clamp or hold it in place with rubber bands while the glue dries. It's recommended that you let it dry overnight to ensure a strong joint.



Now sand the ply so it is flush with the front and rear of the tray. Glue the front MDF piece in place. The cut-out should face left as shown in the picture



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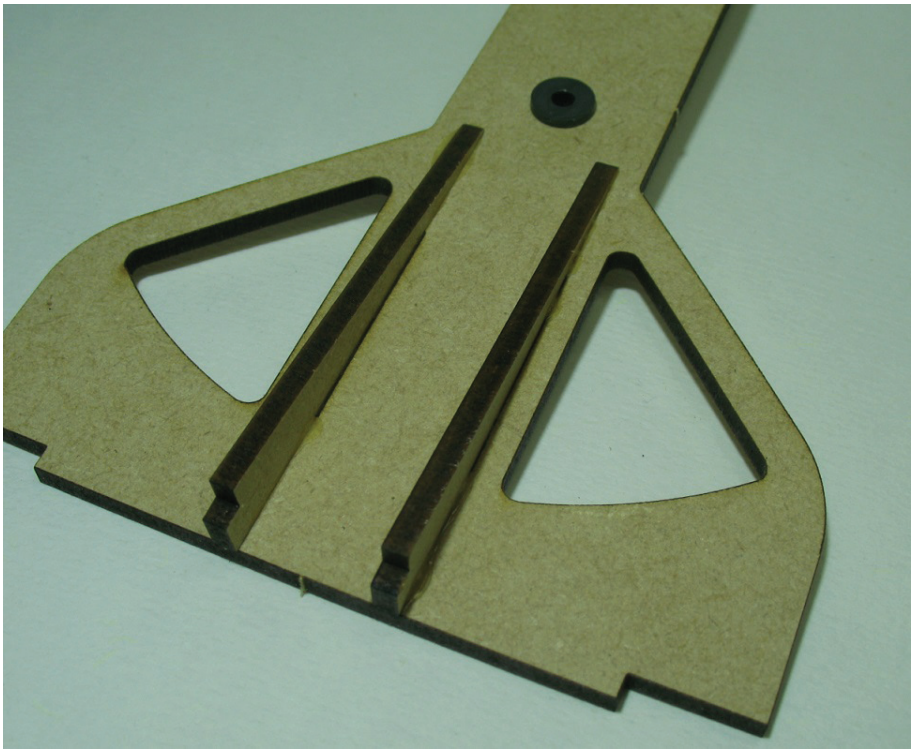
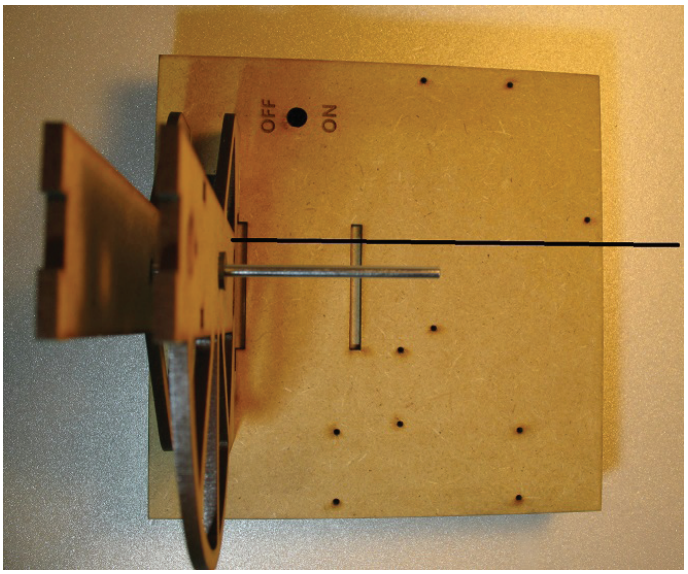
Uprights

Glue the supports to the rear upright. Glue them to the side the bearing is inserted from.



Glue the uprights onto the base. Insert the 3mm rod in the bearings. The front upright can be slid a bit left/right. Slide it so the rod spots parallel with the base sides. This ensures the wheel runs true between the uprights.



The bottom of the base can be used to ensure the front upright is square to the base. A couple of rubber bands will hold it in place. Don’t glue the top piece in place yet so you avoid having to cut the rubber band.

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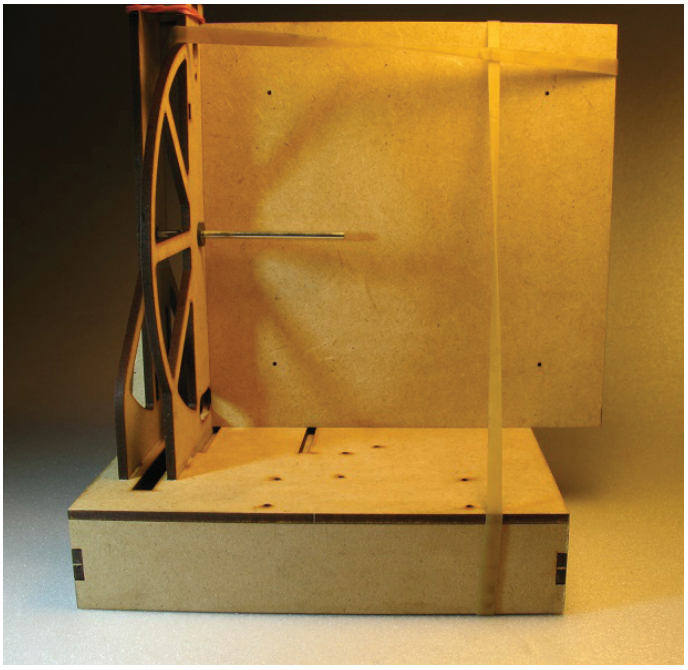
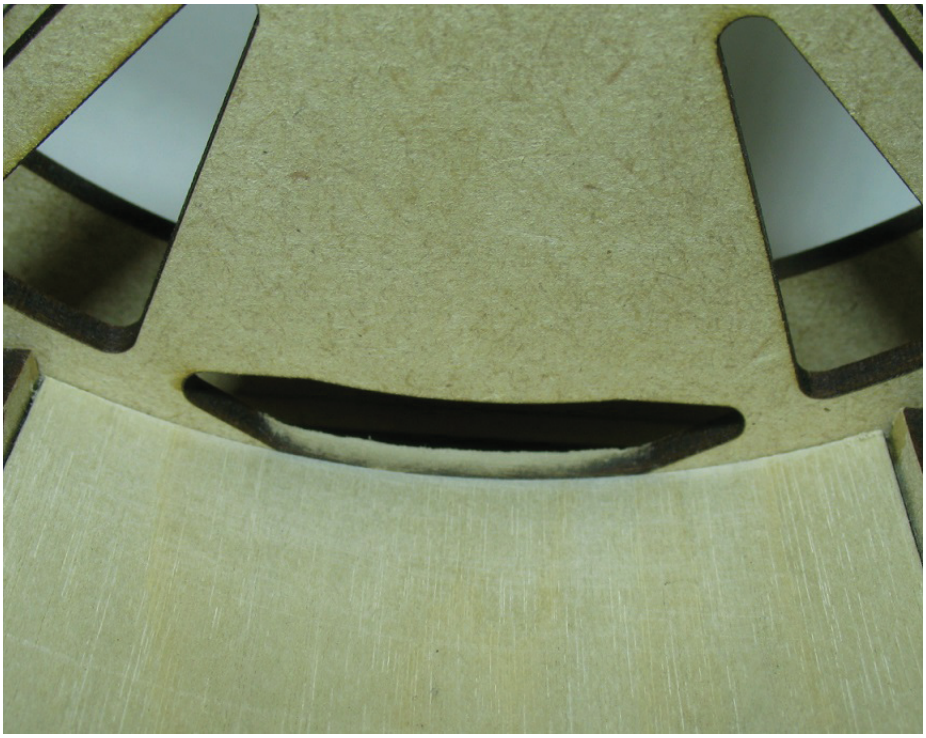


Once the glue on the uprights has set you can glue the top piece in place.

The ball entry slot on the front upright needs to be sanded to a slight angle so the balls roll into the wheel unhindered. Temporarily mount the ball tray and front upright onto the base and insert the wheel so you can see how much to sand the bottom edge of the entry slot. It should be one smooth slope. Only a very small amount of sanding is required. If you sand off too much the balls may struggle to enter the holes in the wheel.



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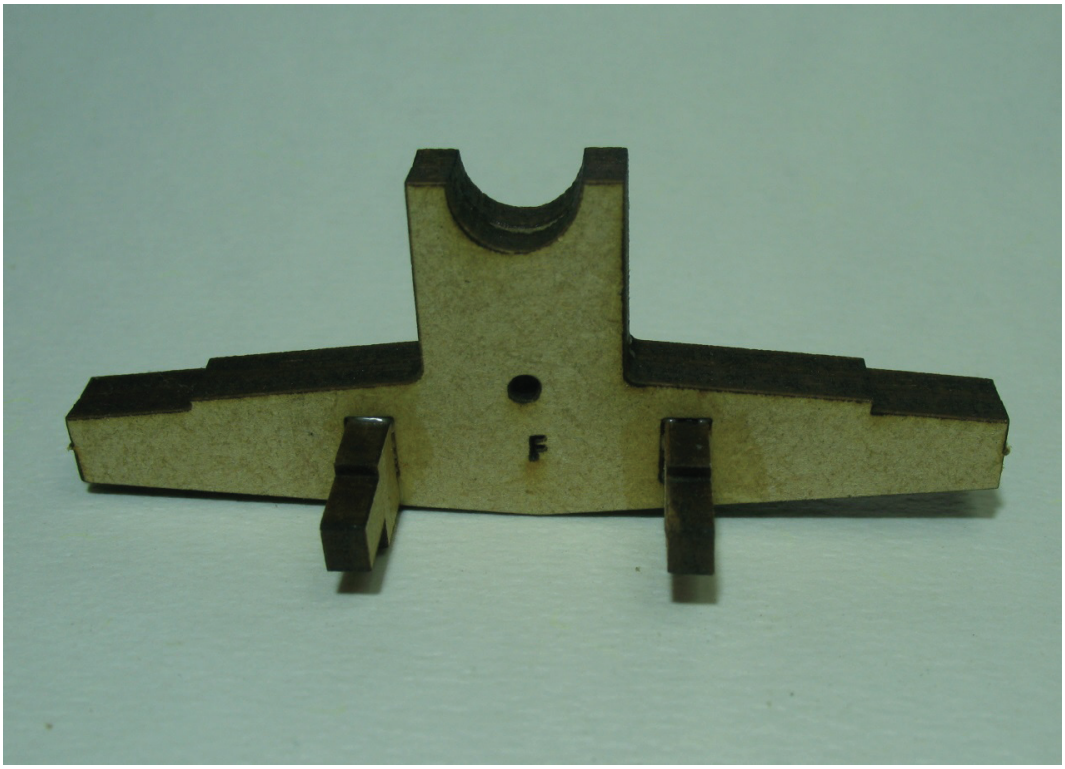
Track swtch (flip/flop)

Toggle:
Glue the three parts together as shown I the picture. Apply glue very sparingly so it does not get into the hole.

Switch frame:
The part marked “F” must face the front.



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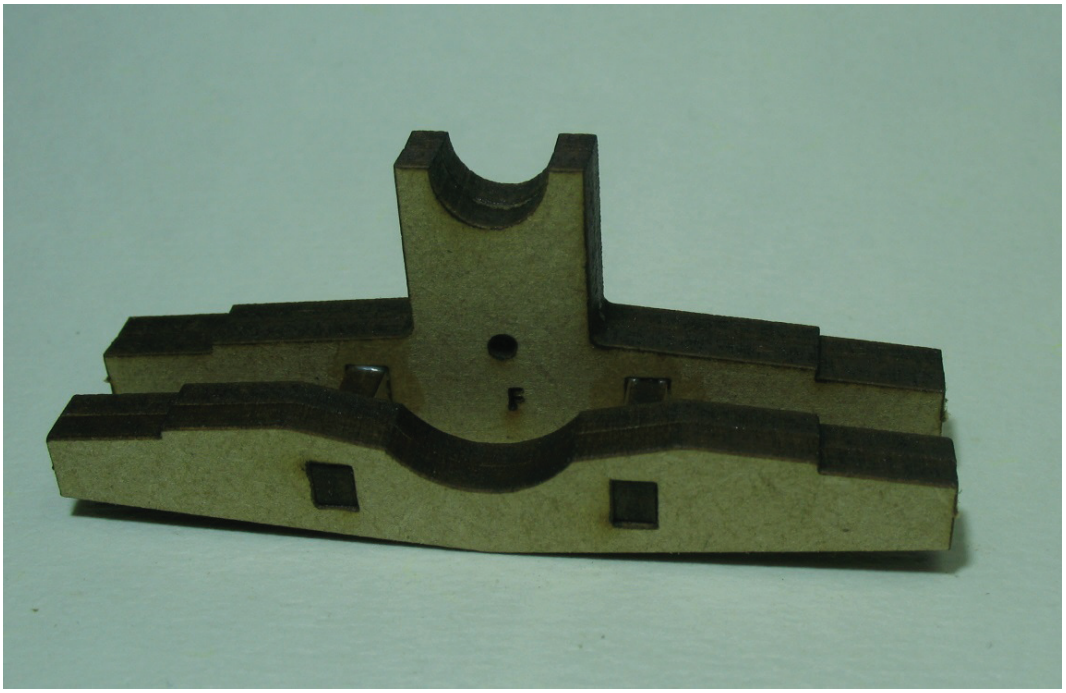
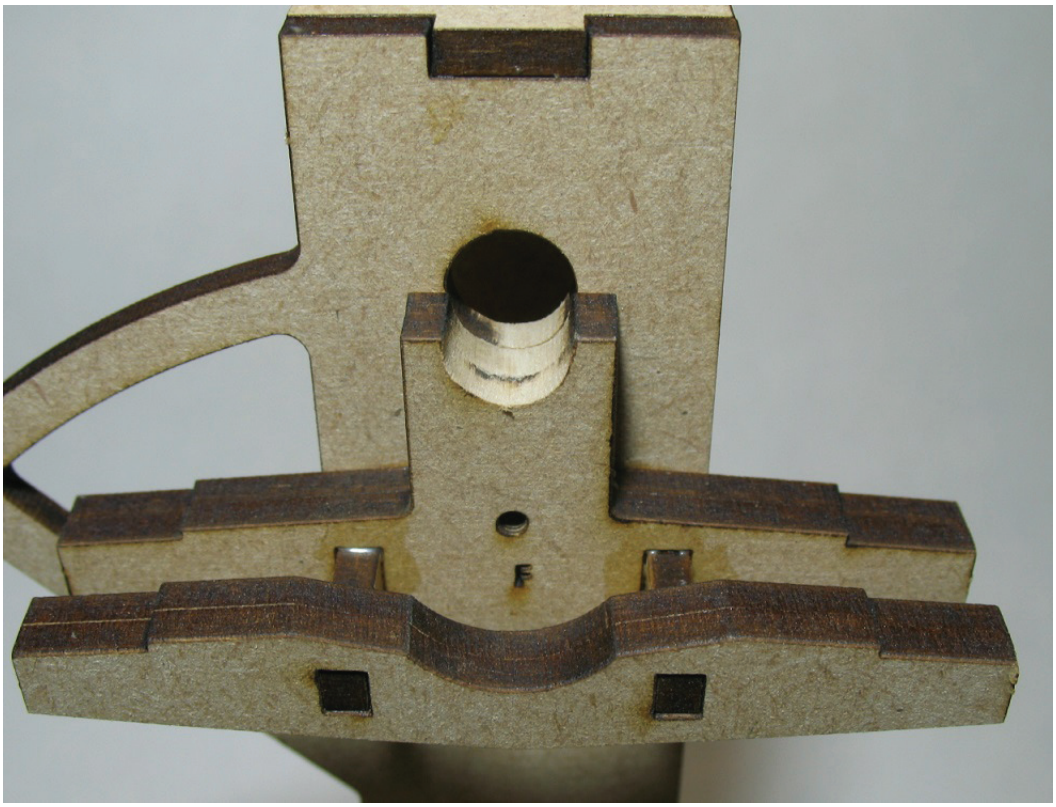


Glue the switch frame onto the upright. Sand the exit hole and frame so there is a smooth downwards slope. Only light sanding is required.



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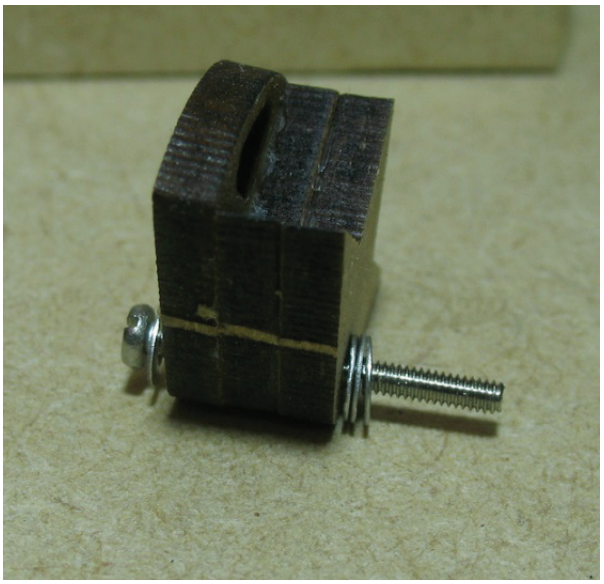
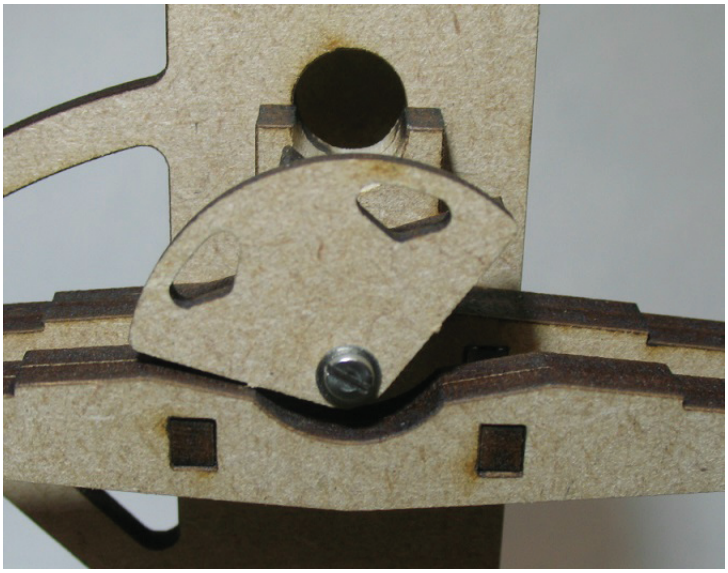
Insert the 2mm bolt in the toggle. Put 1 washer towards the front and 3 on the back. Screw it into the hole in the frame. The toggle must be able to move freely from side to side.

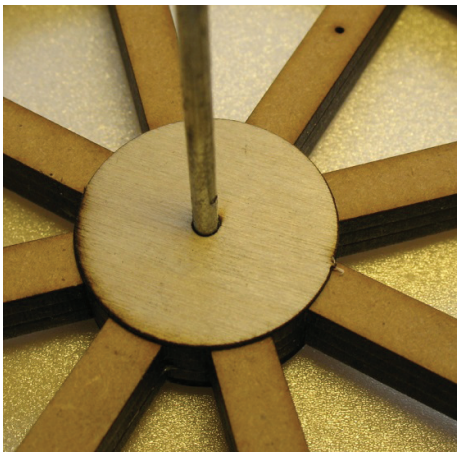




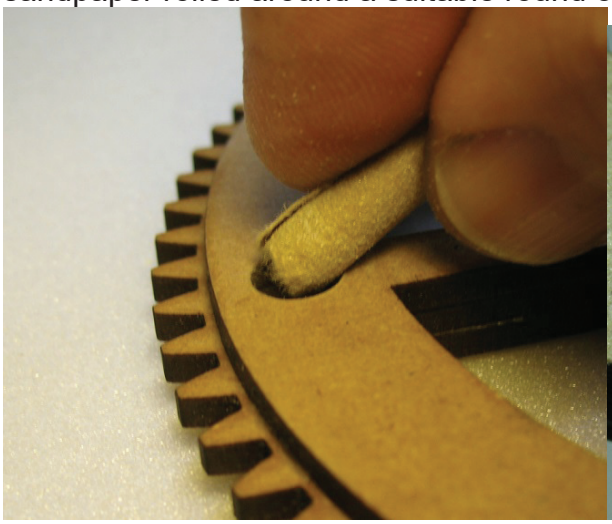
Assembly Instructions for MAD Marble Machine #2

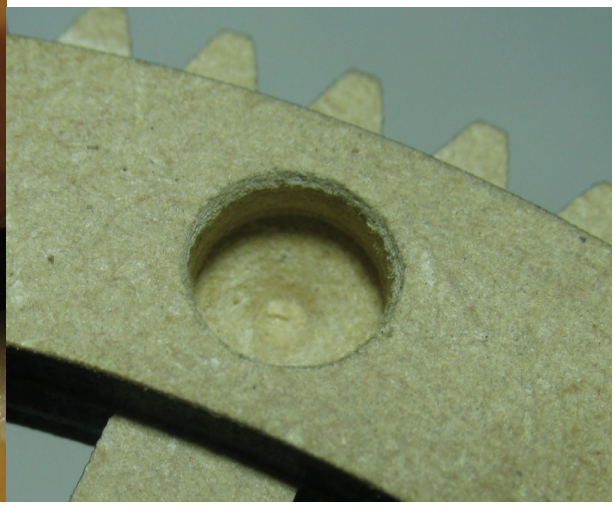
Wheel

The wheel is pre-assembled and has the holes drilled to the correct depth and angle. Glue the ply washers to the wheel, one on the front, two on the back. Use the 3mm rod to align them.

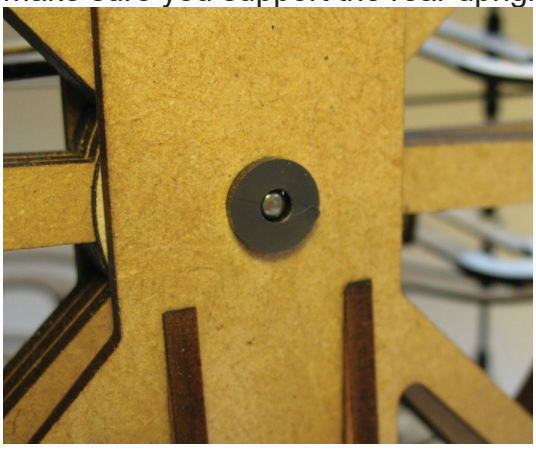


Very lightly chamfer/round the lip of the holes sp they are smooth. This is done with a scrap of sandpaper rolled around a suitable round object like a pen.





Insert the wheel between the uprights and push the axle pin through the wheel. It is a tight fit so make sure you support the rear upright whilst pushing the pin in place.



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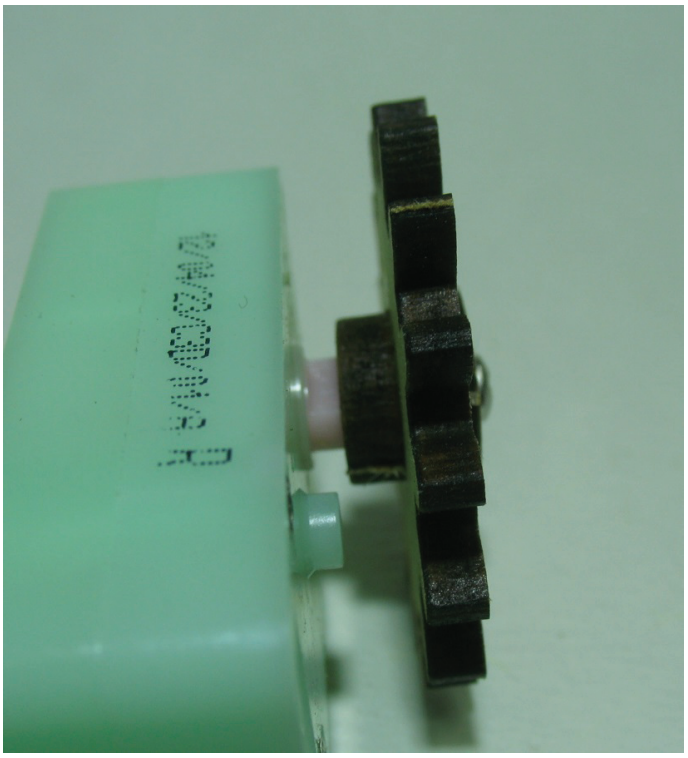
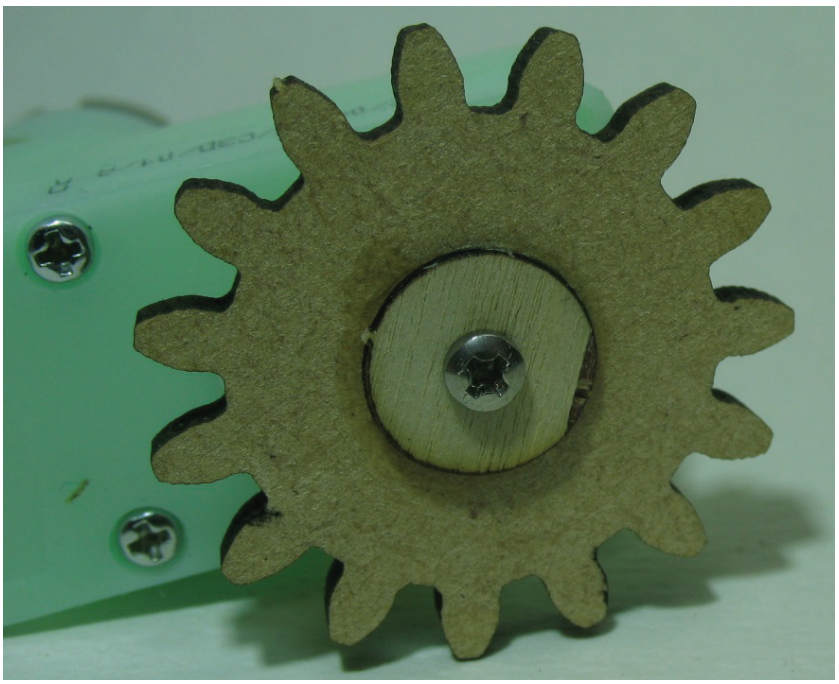
Motor, battery, switch

Push the doubler onto the gearbox shaft just enough so a bit of the shaft protrudes. Add a bit of glue to the doubler, then press the spur gear onto the shaft. Put a bit of glue on the plywood doubler and screw it onto the shaft using the small self tapper. Mount the motor in the frame and secure it with a couple of rubber bands.





If you find that the mesh with the large gear is a little on the tight side, a spacer or two cut from thin card can be placed under the motor.

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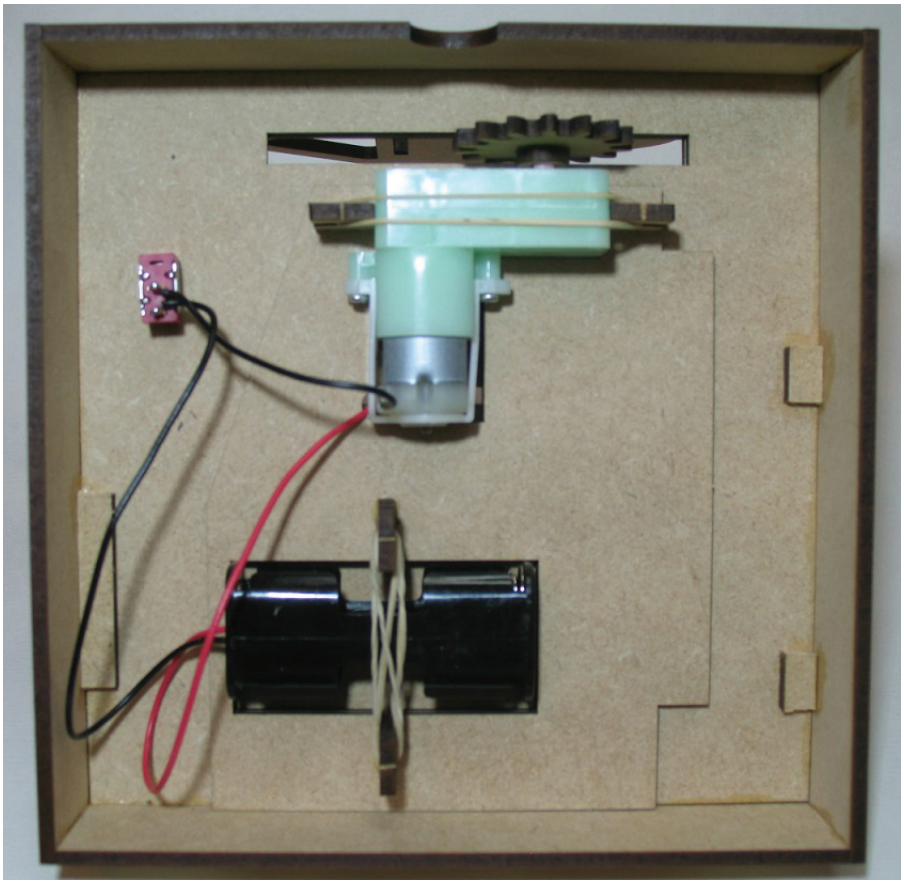
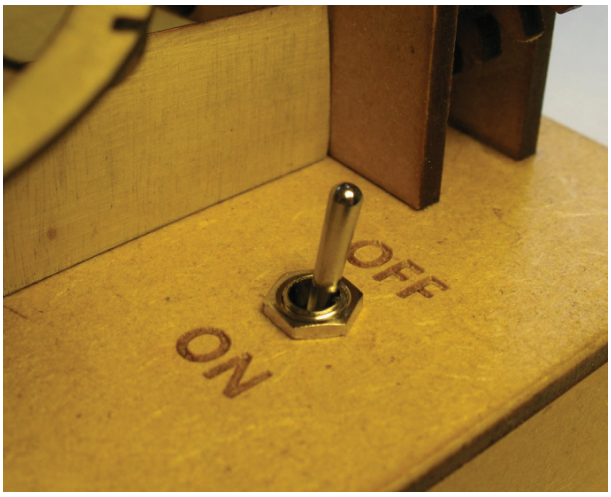
The battery clip is also held in place with rubber bands. Insert the switch through the hole and orient it according to the on/off markings. The serrated washer should be on the underside of the base.





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Tracks

The track spacers should be glued in place while the tracks are still retained in their respective sheets. The spacers are mounted on the undersides of the tracks (top side is marked by an X so you place the spacers on the side without the X). Put a blob of glue on a piece of paper and dip the spacers in the glue, then fit them in the cut-outs in the track.

Carefully place a flat sheet on top of the spacers and weigh it down (glass of water, full soda can etc. is enough weight) then leave the glue to set. Once dry you can varnish the track. It is easier to do while the tracks are still retained in the sheets. Do not varnish the parts where the track joiners are to be fitted. If you do, the glue joint will be weak. Separate the tracks from the sheet by carefully cutting the little retaining tabs with a sharp hobby knife. The pips should be sanded off the inside of the track so it is smooth and the balls can roll unobstructed. Glue the track joiners to one track section and allow the glue to dry before glueing sections together. It is easier than trying to join the sections in one go. Study the pictures carefully before joining the track sections so you know what goes where.

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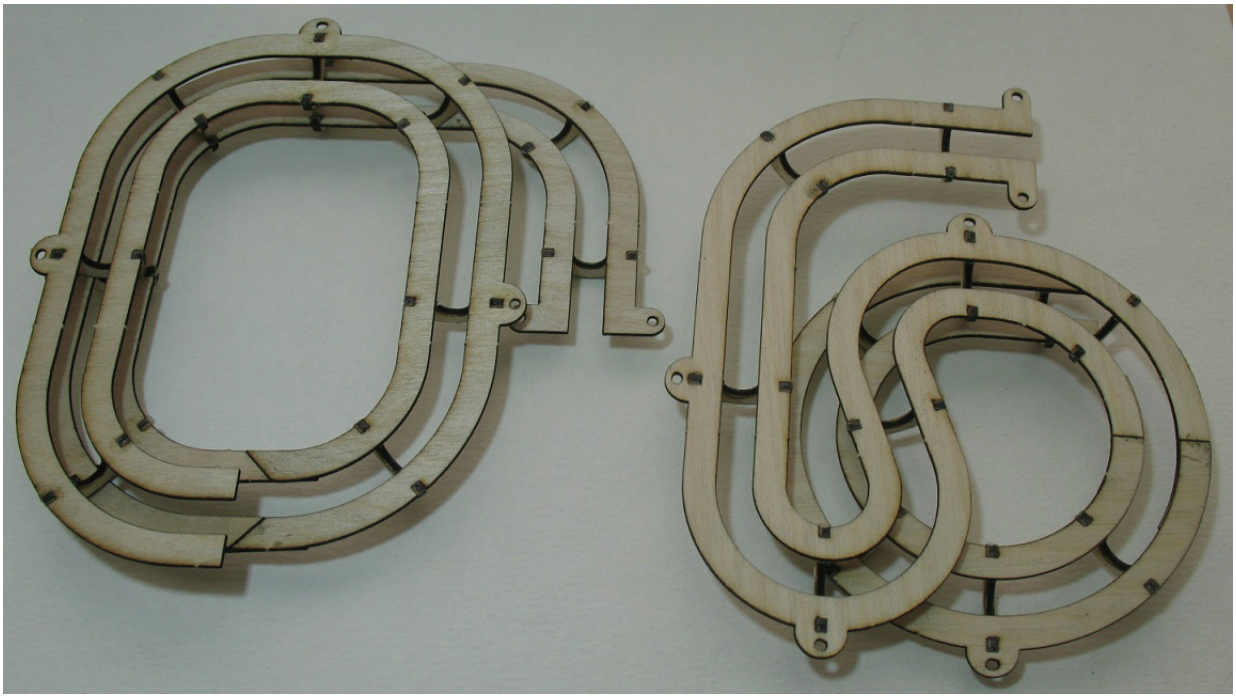

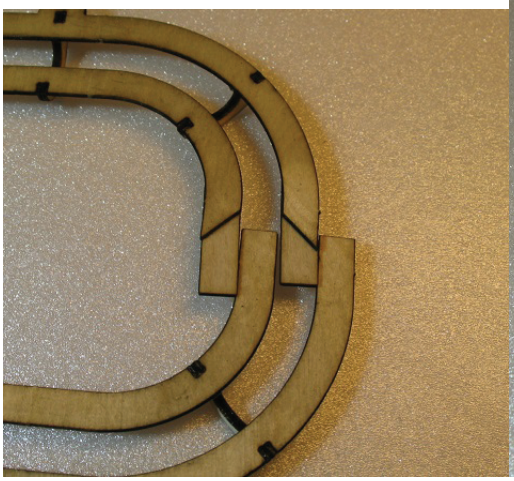

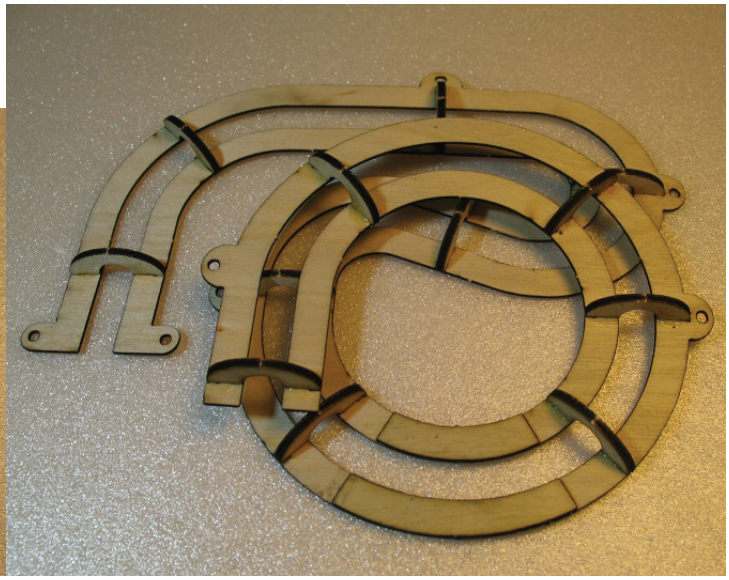

Glue the end doublers onto the zig-zag track pieces. These go on the side of the sheet marked with an X (opposite side of the spacers!).

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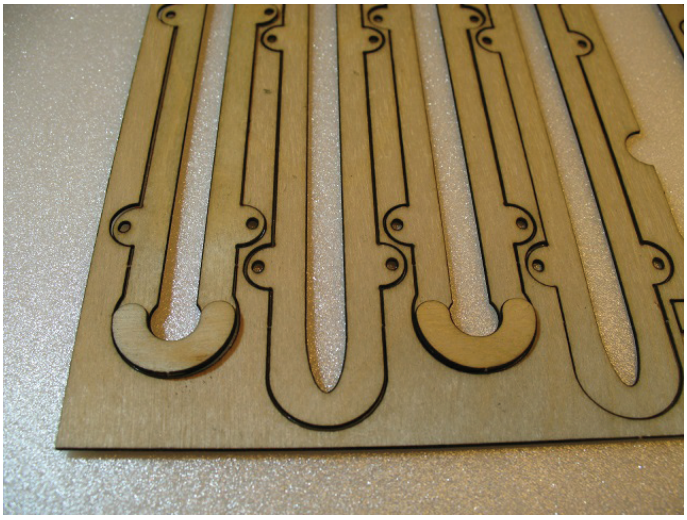
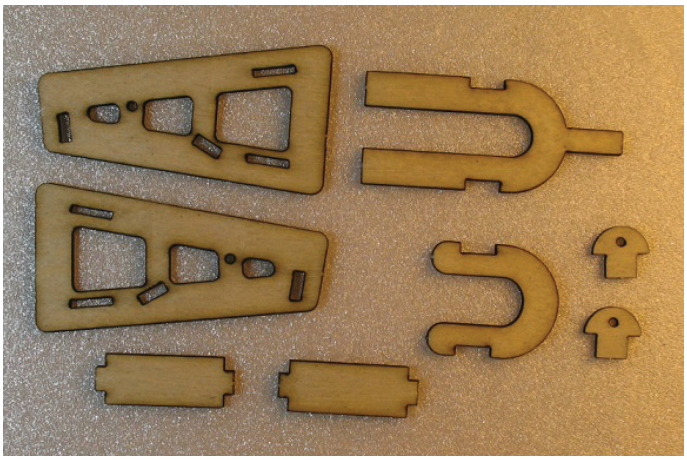
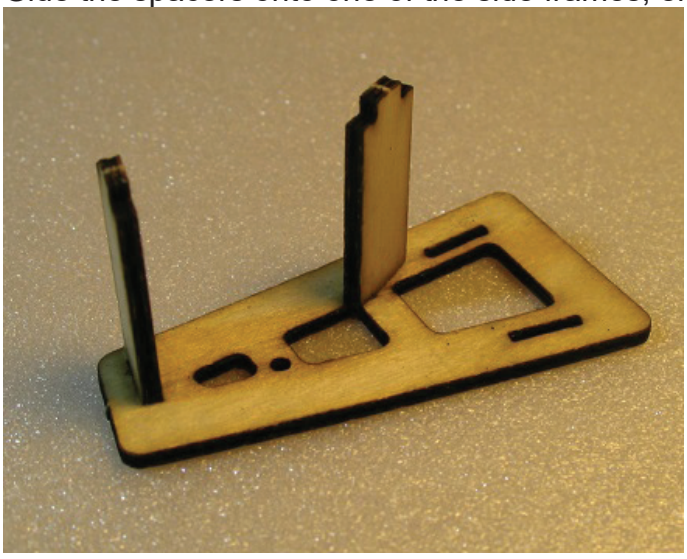


Accumulator

Separate the accumulator parts from the 1.5mm ply sheet



Glue the spacers onto one of the side frames, ensuring they are square to the frame.



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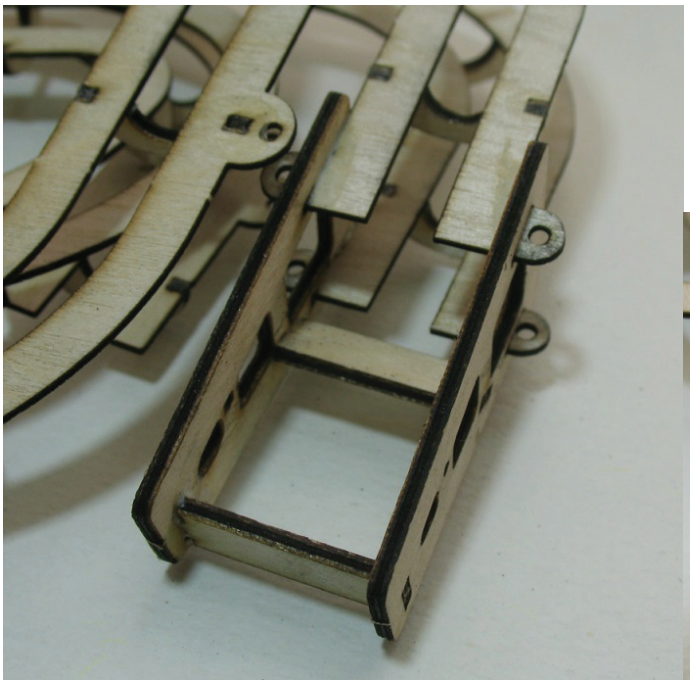
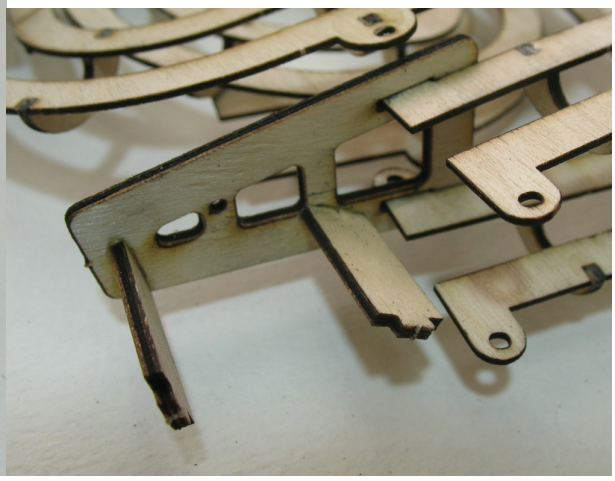
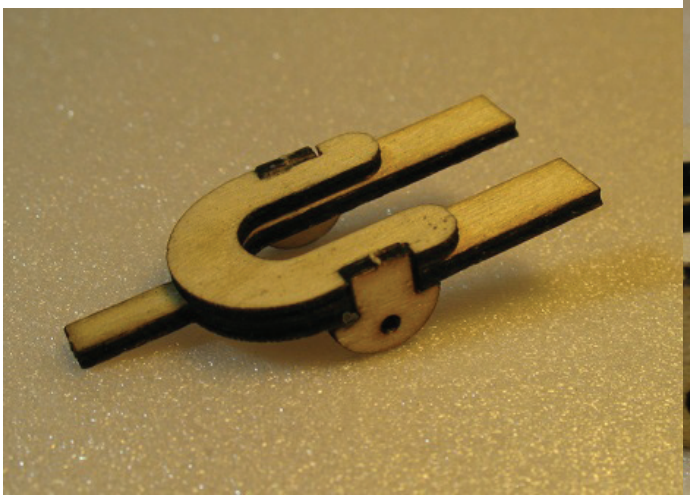
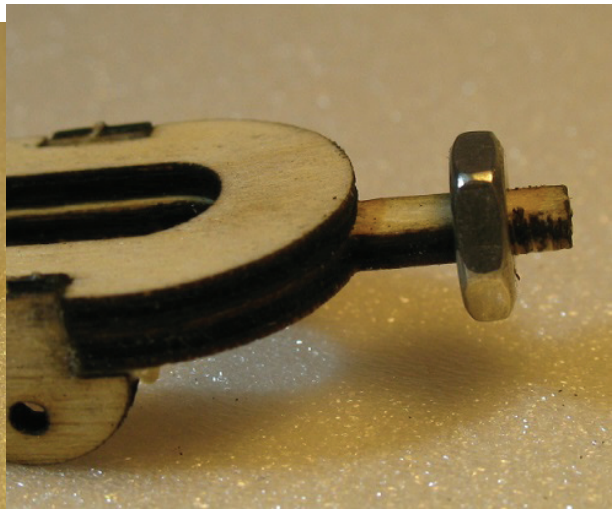
Insert the tracks into the side frame and glue the other side frame in place. With the frame oriented as in the picture the track with the S-shaped section should be inserted into the bottom slots.





Glue the seesaw parts together as shown below. Carefully thread the M4 nut onto the prong. If it is very tight, sand the prong a little bit. The nut acts as a counterbalance and by moving it along the prong you can balance the see-saw so it tips when 3 ball are on it.





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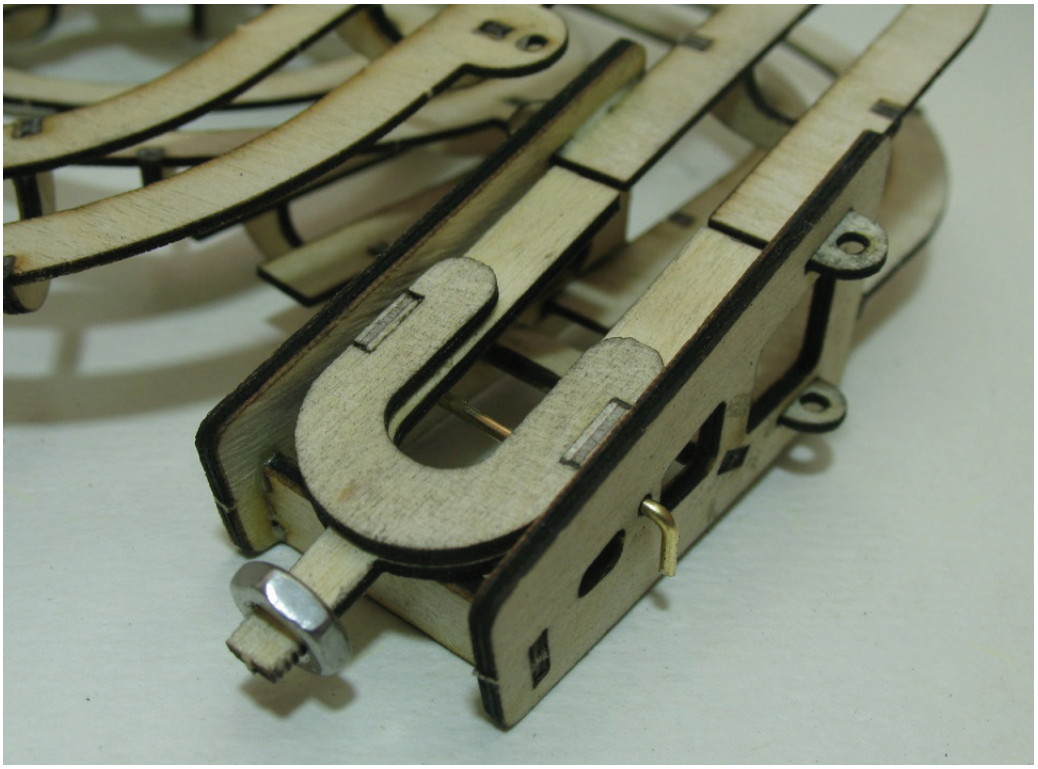
Use the supplied length of brass wire to mount the seesaw in the frame. It must be free to move. If it binds, sand the sides of the seesaw until it moves freely.



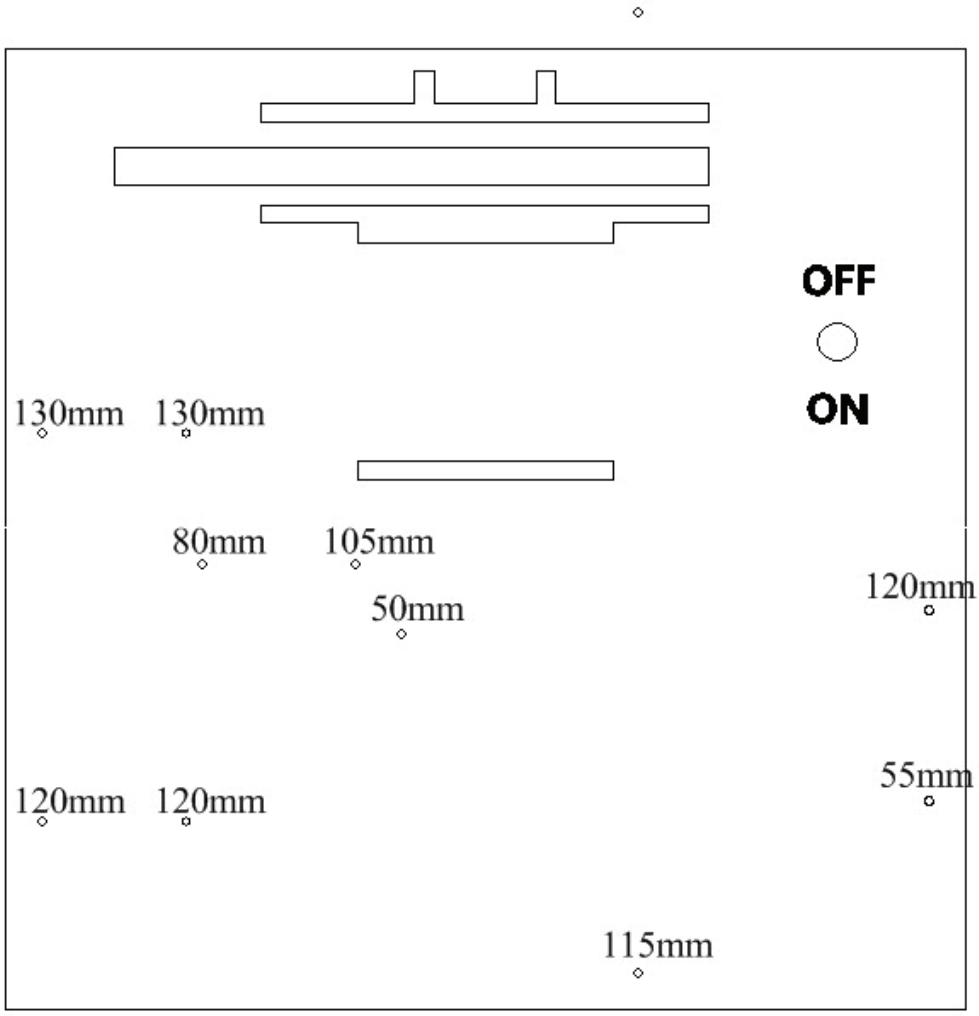
Assembly Instructions for MAD Marble Machine #2

Mounting the track

Start by cutting the carbon rods to the correct lengths listed below. Remember: measure twice, cut once! Roll them back and forth under a sharp knife a few times. They can now easily be snapped apart.

2x130mm (or 129.5mm if you are superstitious), 3x120mm, 1x115mm, 1x105mm, 1x80mm, 1x55mm, 1x50mm

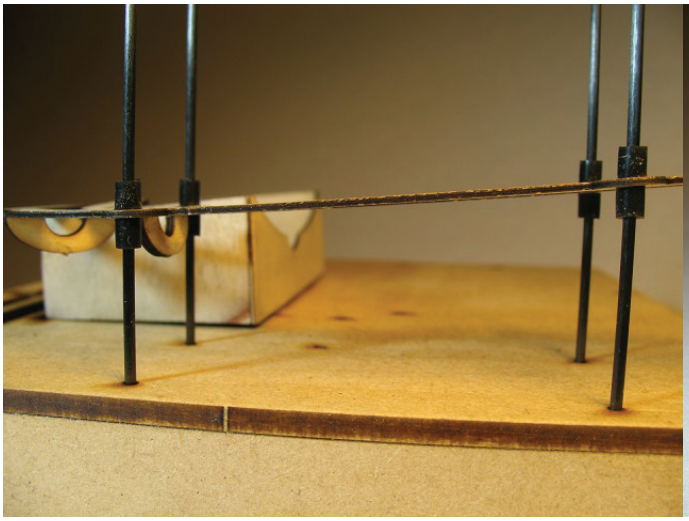
The location on the base is shown below

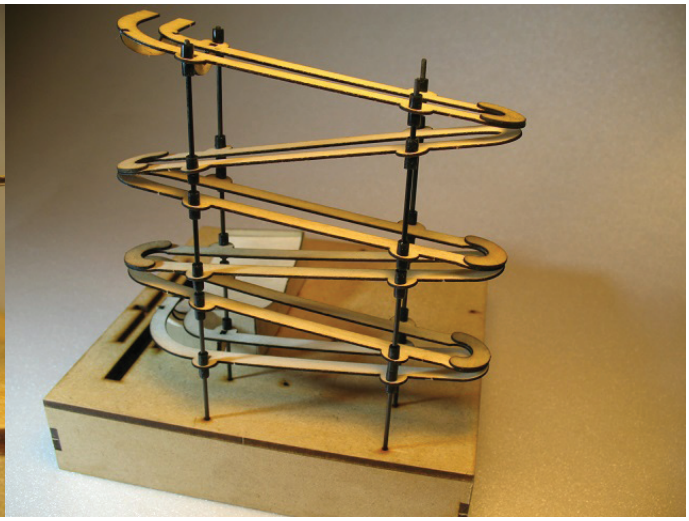


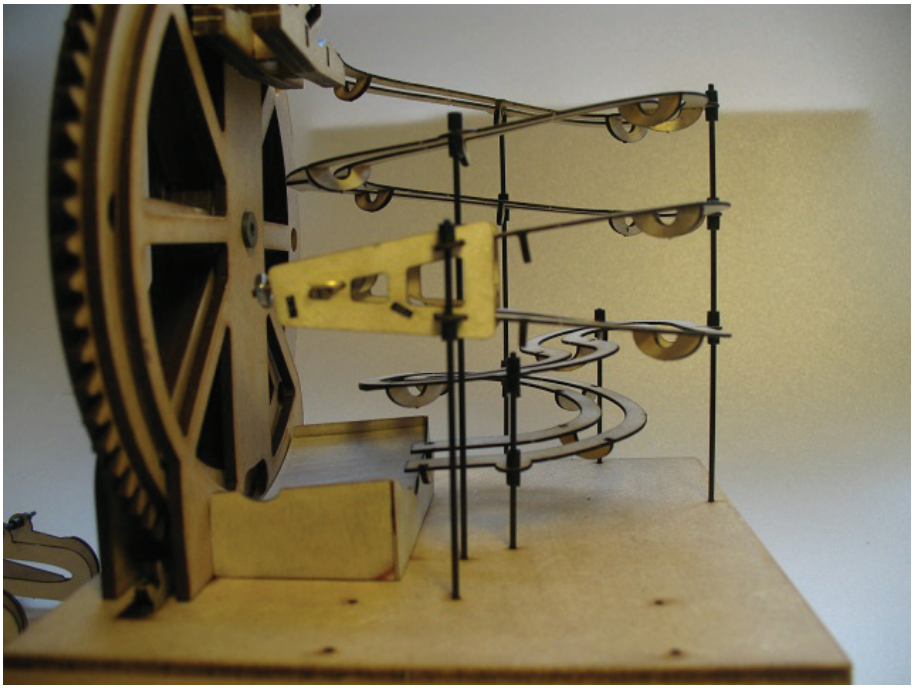
Push the rods into the holes in the base. Don't glue them in place. It is easiest to do the zig-zag track first, then remove it and do the track with the accumulator. It gives you more space to make adjustments.

Assembly Instructions for MAD Marble Machine #2

The silicone tubing is pre-cut and the individual spacers are easily pulled apart. Slide 4 silicone tube spacers onto the rods. Slide the bottom track onto the rods, then add 4 spacers. Add another 4 spacer, track, etc. - you've got the idea by now.

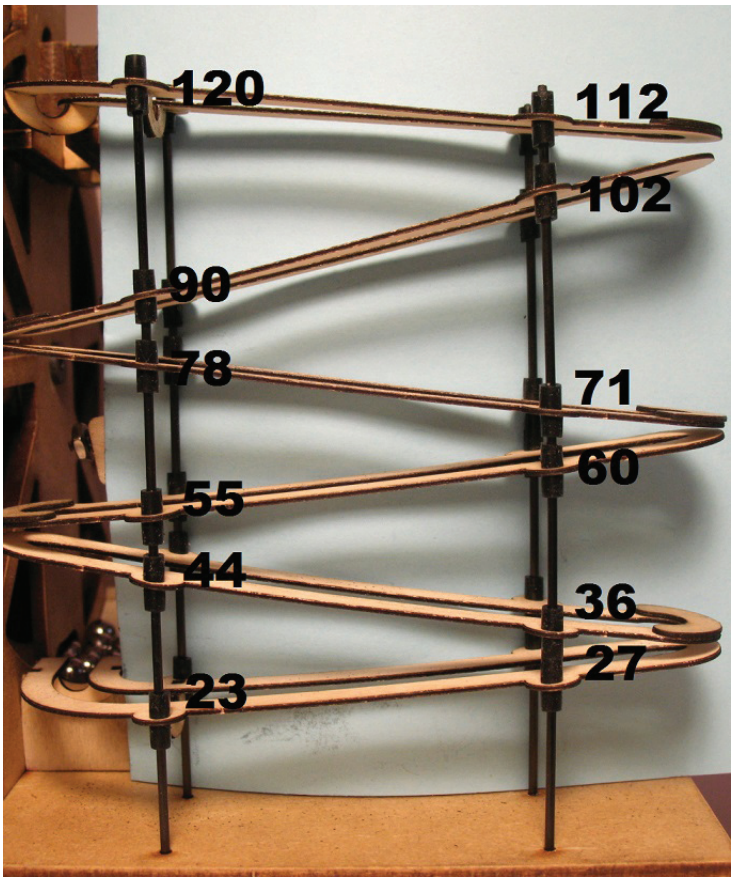


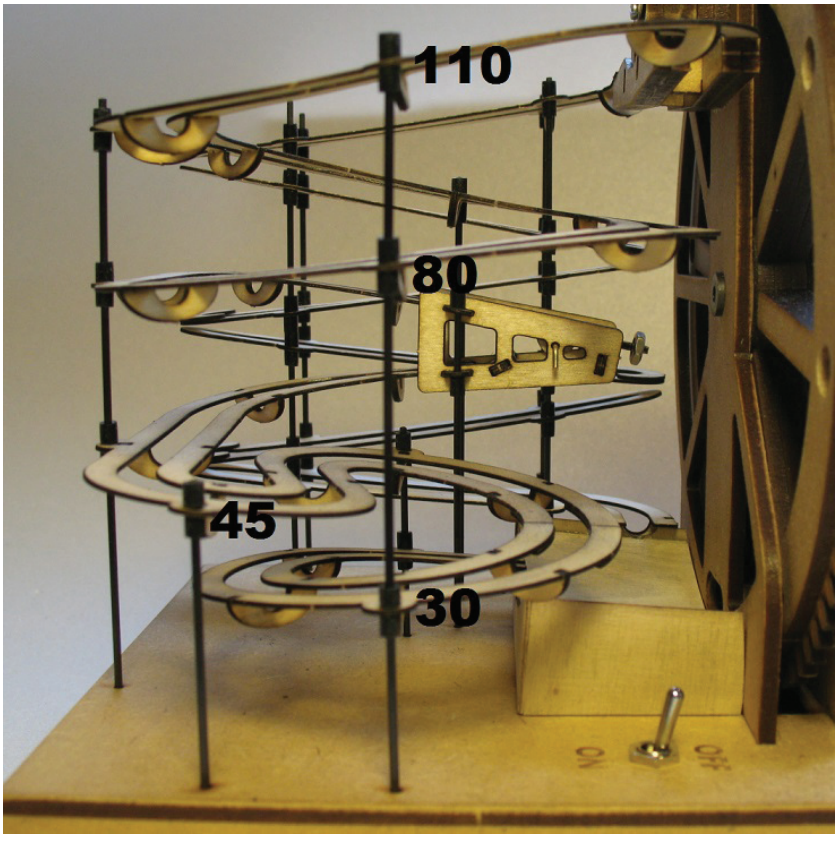




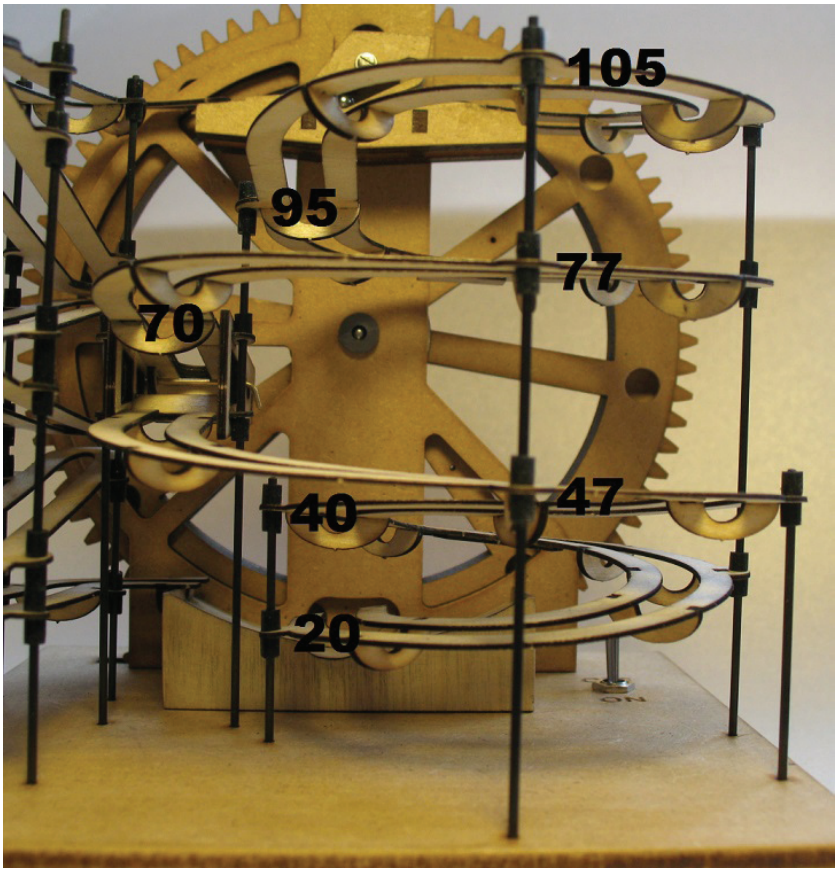
The process is similar for the accumulator track but you may find it is easier to assemble it freehand, then mount the rods in the base and do the final adjustment of the track. The pictures below give approximate positions of the track. The measurement is taken from the base to the top of the track where it is held in place by the silicone tubing. The measurements are just a guideline and you can can change them within reason.The silicon tubing can easily be cut with scissors if you need to resize it.

Assembly Instructions for MAD Marble Machine #2

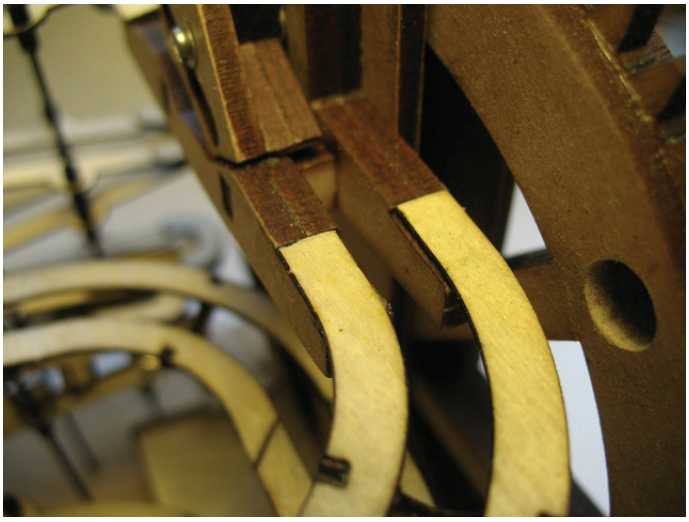




Assembly Instructions for MAD Marble Machine #2



Once both tracks are completed and mounted on the base you can glue them onto the track switch as per the picture below.

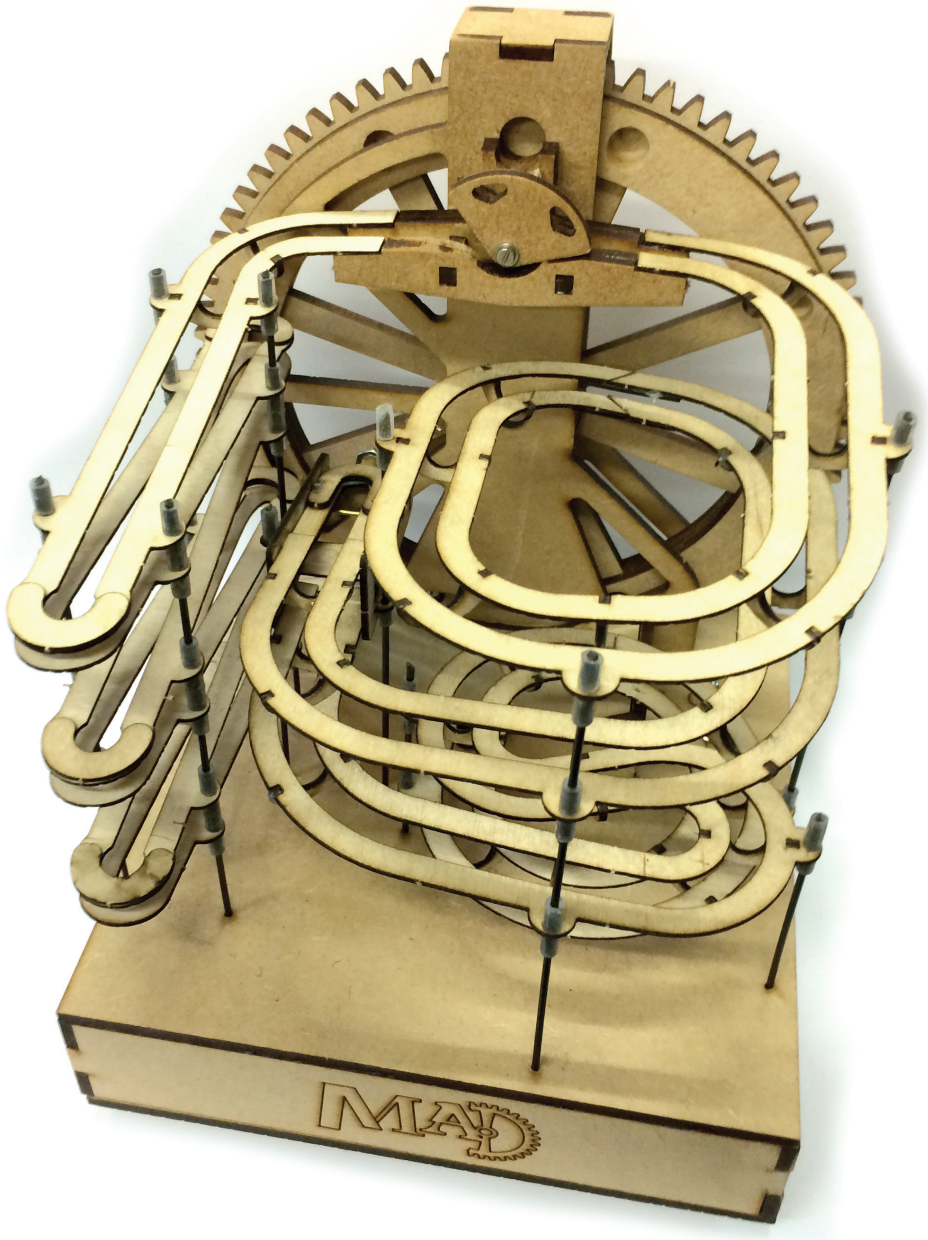


Assembly Instructions for MAD Marble Machine #2

Final touches

Mount the ball tray onto the base. It is not necessary to glue it in place as it's a fairly tight fit but you can of course do so if you prefer this.

Place the marble machine on a level surface (this is important – operation might be affected if the machine is not level). Load the balls into the tray, hit the switch and sit back and admire your handiwork in action. If the accumulator see-saw doesn't tip with 3 balls on it you may need to re-adjust the nut until the balance is right.



Assembly Instructions for MAD Marble Machine #2