

Make your own motorised vehicle

Follow this step by step guide on how to make your own pulley-driven motorised vehicle. This 'make' is useful for KS2 pupils exploring the use of electric circuits, pulleys, wheels, axles and bearings. It is also suitable for KS3 students investigating series circuits, friction, average speed and energy transfers; simple machines giving bigger force at the expense of smaller movement and vice versa.

What you'll need

Components and materials:

Battery holder with 2 AA zinc chloride cells fitted (**do not use alkaline or rechargeable cells**—if you accidentally short circuit your battery these can get extremely hot)

Battery snap

Toggle switch

Motor

Motor mount

3 crocodile leads

Rubber band ~ 1.5 mm x 1.5 mm x 8 cm long

Small plastic pulley

Wooden pulley 34 mm diameter

4 wooden wheels 35 mm diameter

2 jumbo plastic drinking straws 6 mm diameter

8 cable ties 20 cm long

16 card triangle axle supports

Balloon

Wooden dowel 5 mm diameter x 30 cm long

Square section wood 8 mm x 68 cm long

Tools:

Ruler

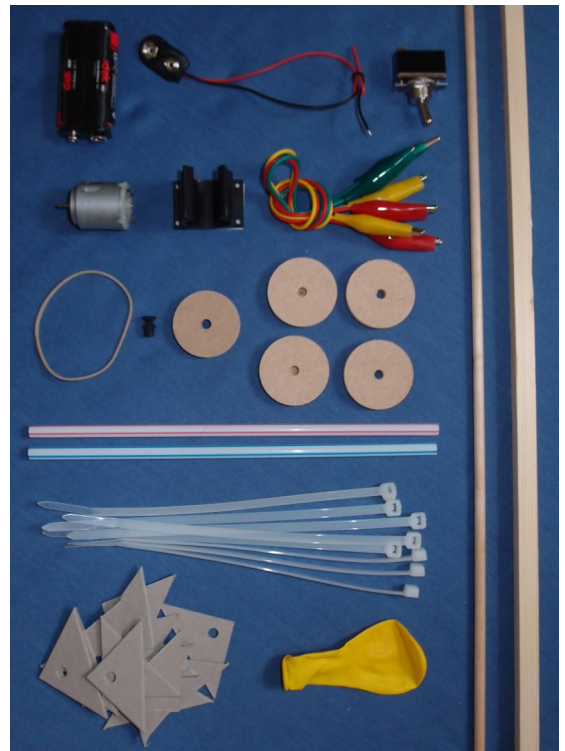
Pencil

Pointed scissors

Junior hacksaw and vice

Sandpaper

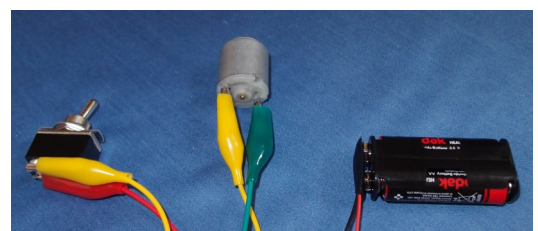
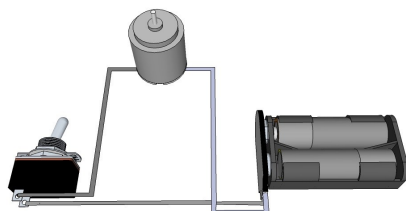
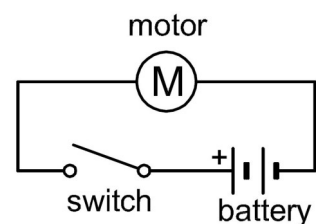
Low melt temperature glue gun



Step 1.

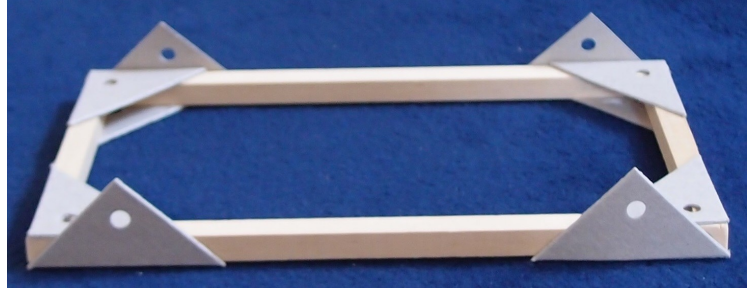
Make this circuit and check that the motor shaft goes round when you switch on. Be careful not to short circuit your battery (i.e. connect the wires from your battery directly together) - they must go via the motor.

If you tie the wires from your battery snap in a reef knot as shown on the right then you are less likely to accidentally short circuit your battery.



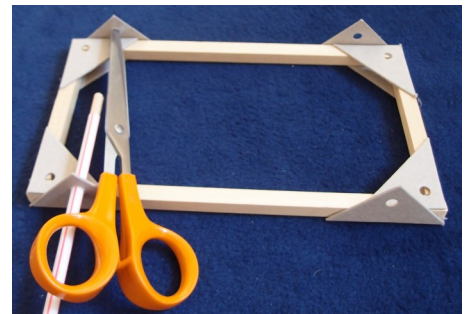
Step 2.

Cut two 20 cm lengths of square section wood and three 9 cm lengths. Smooth the ends with sandpaper. Check which is the shortest of the 9 cm lengths and set it aside. Use the glue gun to make a rectangular frame with the other four lengths as shown below, and reinforce the corners with card triangles. Attach four card triangle axle supports as shown below right; try to make them symmetrical.



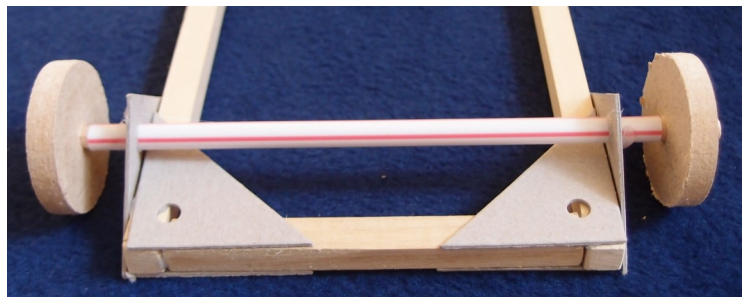
Step 3.

Cut two 15 cm lengths of wooden dowel to make axles, and smooth the ends. Push a wheel onto the end of one of the axles; it should be a tight fit. Cut a 13 cm length of straw to make a bearing, and slide over the axle. Slide the axle and bearing assembly through a pair of axle holders; you will need to enlarge the holes in the axle holders very slightly by pushing the nose of the scissors into the hole as shown and twisting them round a few times. Don't make the hole too big as the straw needs to fit tightly. Check the axle rotates easily in the straw.



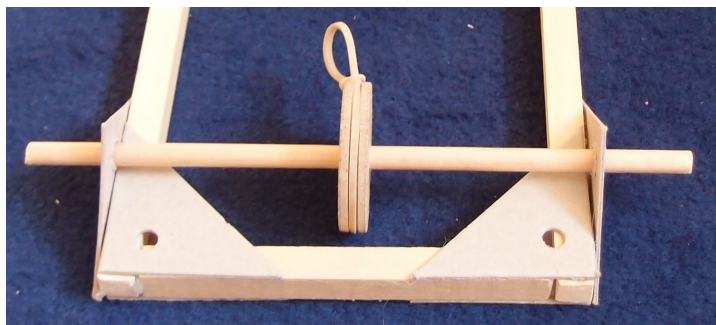
Step 4.

Glue the straw to the axle holder to stop it sliding about when in use (without getting glue on the axle). If you can't fit the nose of the glue gun into the corner to do this, then you can spread the glue using a lolly stick or similar. Take the axle out of the straw and fit one of the wheels. Put it back and fit the second wheel. The wheels should be a tight fit on the axle. Adjust so that there is roughly a 1 mm gap between the wheels and the ends of the straw. Hold the frame and spin the wheels to check the wheel/axle assembly still rotates freely.



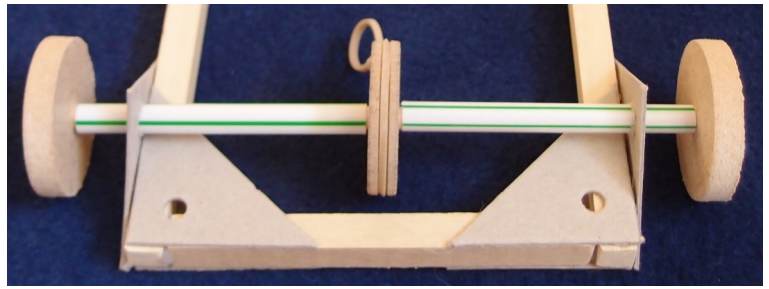
Step 5.

Slide the wooden pulley to the centre of the second axle; it should be a tight fit. Fit the rubber band over the pulley; you can tie a slip knot in it to hold it in place during assembly. Cut two 6.5 cm lengths of straw. Enlarge the hole in the axle holders very slightly until the straw will just slide in; it should fit tightly. Slide the axle assembly into the two axle holders as shown.



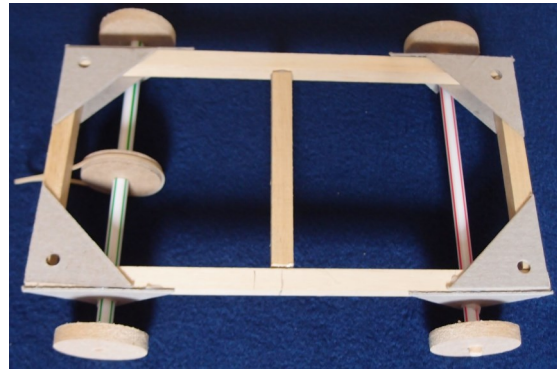
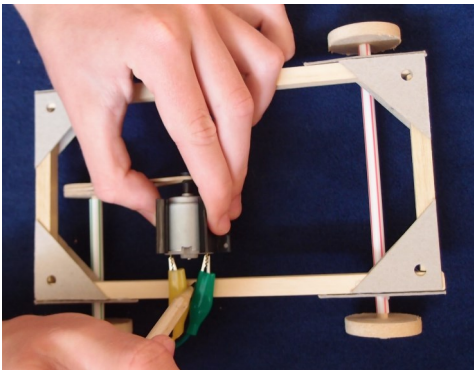
Step 6.

Slide on the two straw pieces, then fit the wheels. Adjust until there is roughly a 1 mm gap between the ends of the straws and the pulley and wheels. Undo the slip knot in the rubber band, hold the frame and spin the wheels, to check the wheel and axle assembly rotates freely, whilst the straws remain stationary. Glue the straws in place, without getting glue on the wheels or axles.



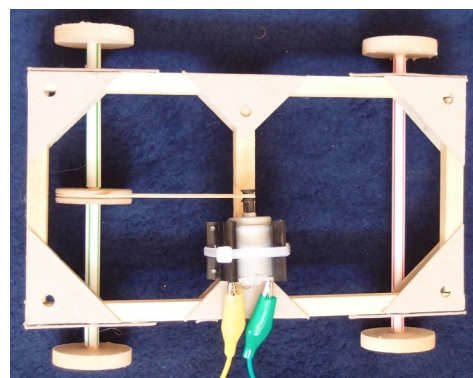
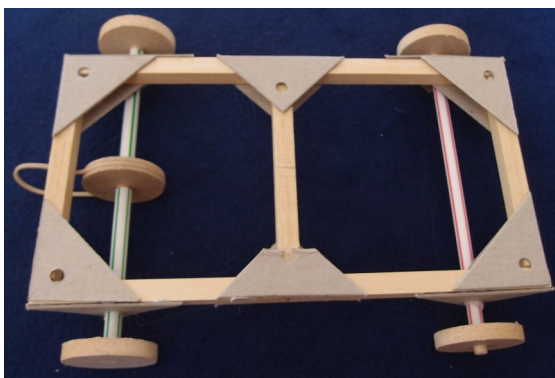
Step 7.

Press the small pulley onto the motor shaft, and clip the motor into the motor mount. Fit the rubber band onto the small pulley and position the motor so that the rubber band is just tight but not stretched. Mark the centre line of the motor on the wooden frame as shown below left. Make another mark 1 cm further along the frame, as you will need to tension (i.e. stretch) the rubber band. Glue the final 9 cm length of wood across the frame with the centre in line with your second mark as shown below right.



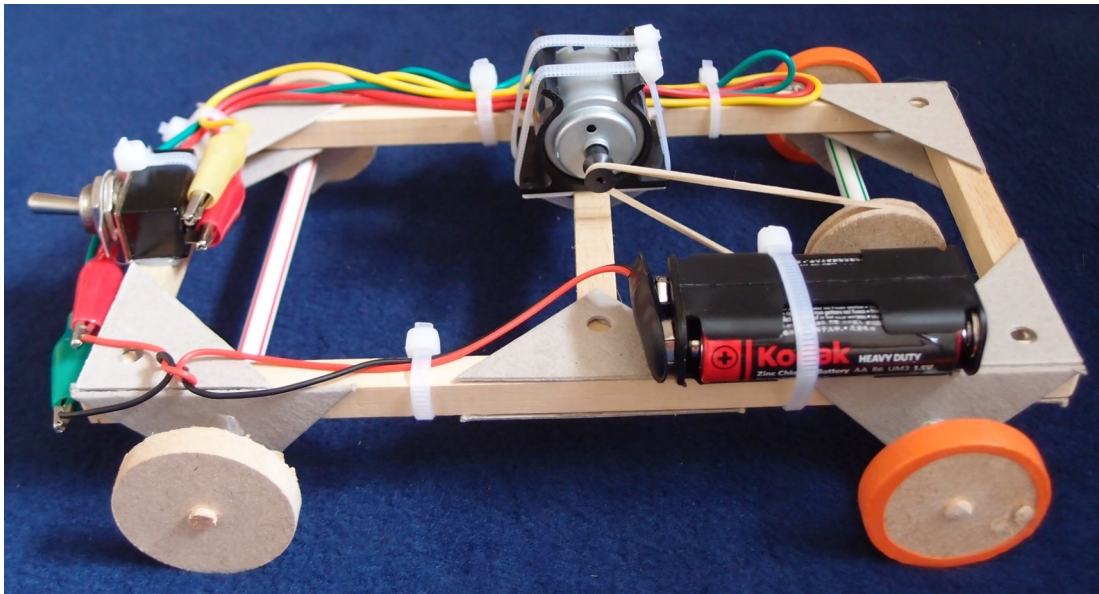
Step 8.

Reinforce with card triangles, but before gluing cut about 1.5 cm off the card triangle where the motor will fit, so that the motor has a flat surface to mount onto. Place your motor chassis the right way up (i.e. so that the wheels are on the bottom), and stick your motor assembly to the top of your crosspiece so that the two pulley centres are exactly in line as shown below right, and then cable tie it firmly in place. Fit the rubber band onto the pulley.



Step 9.

Work out where to attach your battery and switch, making sure nothing will interfere with the rotating parts. Glue and cable tie the components firmly to the frame. Tidy up your wires, making sure the crocodile clips don't touch, and cable tie these as well. Trim off the ends of the cable ties.



Step 10.

Try out your motorised vehicle on different surfaces. You may find the driving wheels slip on a smooth surface, in which case you can cut sections of balloon and fit them as tyres. You can time your vehicle over a known distance to calculate the speed. You can also use a ramp to find out how steep a slope it can climb. You could try different wheel sizes and compare the performance of the vehicle. If you want your vehicle to go in the opposite direction you can swap over the crocodile clips on the back of the motor.