

Fan Cart

This version of the Fan Cart has evolved from a snack write-up shared by Kevin Doyle during the Summer 2000 Institute.

Material

- (1) masonite platform, 4 in x 12 in
- (2) 3/16 in wooden dowels, 6 in long, for axles
- (3) 3/16 in dowel, 7 in long, for mast & spars on sail

- (1) wood block, 2 in x 2 in x 3/4 in thick
- (2) wood blocks, 1 in x 3 in x 3/4 in thick
- (2) drinking straws, cut to 5 in long
- (4) CD's

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- (4) pegboard squares, 1 in x 1 in, cut so pegboard hole is in middle

OR

- (4) 1/4L beveled faucet washers (19/32 in O.D.)

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- (1) 7 1/2 in cable tie (ZIP tie) with mounting head for screw, **AND** (1) 8 x 3/4 in sheet metal screw, Phillips

OR

- (1) spring clip broom holder for motor mount, **AND** (1) sheet metal screw or round head wood screw, approximately 8 x 3/4 in

- (1) 1.5-3 volt electric motor -- Radio Shack #273-223

- (1) propeller, 2-blade, 6 inch, Kelvin or PITSCO

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- (1) battery holder for 2 AA batteries -- Radio Shack #270-382 **AND** (1) 9-volt battery cap -- Radio Shack #270-325 or 270-324

OR

- (1) battery holder for 2 AA batteries, with leads -- Kelvin #220090

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- (2) alligator clips -- e.g., Radio Shack #270-380A Mini Alligator Clips

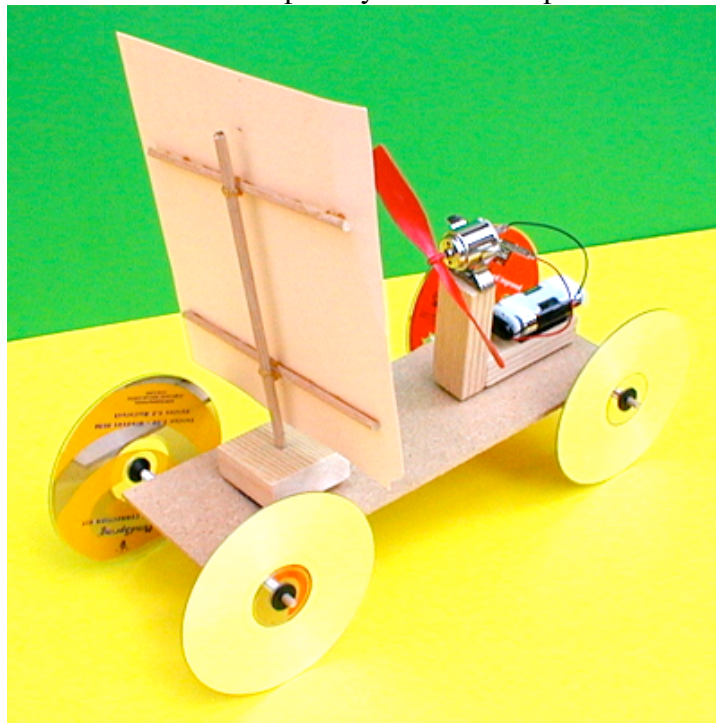
- (2) AA batteries

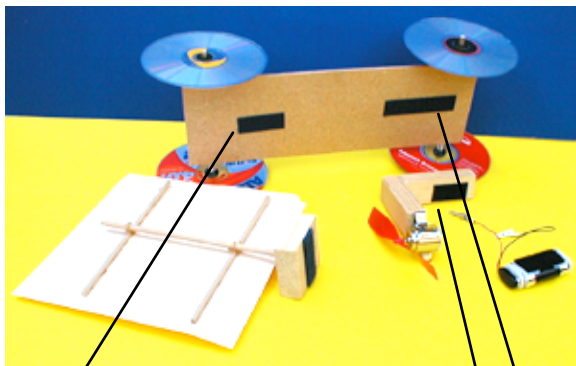
- (1) manila file folder, cut to 8 in x 8 in Velcro, sticky-back, about 7 in

- hot glue gun
- hot glue sticks
- electric drill
- 3/16 in drill bit
- 1/16 in drill bit
- screwdriver

Assembly

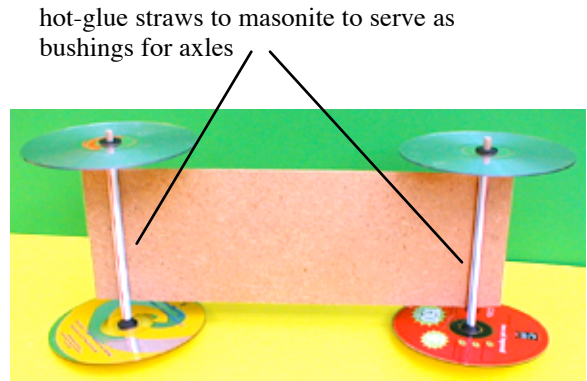
See following photos, notes and comments. A prototype should be available in the shop. The materials list above shows alternative choices of materials for CD hubs, motor mount, and battery holder. Some photos may show use of materials not in use in the shop this year -- ask shop staff which materials are available.





Components: Sail, Body, Fan, Battery

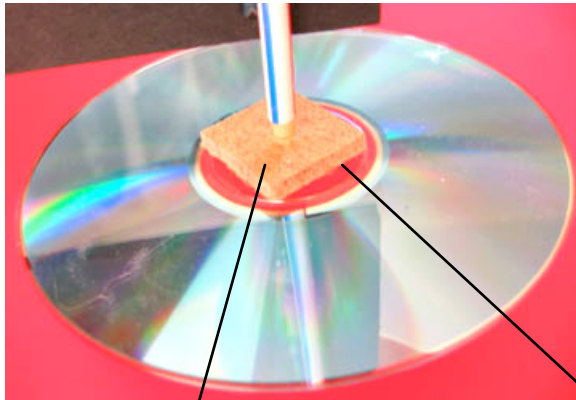
- use 2 inch velcro to attach sail to body
- use 2 inch velcro to attach battery to fan
- use 3 inch velcro to attach fan to body



Bottom View

hot-glue straws to masonite to serve as bushings for axles

Wheel and Axle Assembly: Pegboard hub hot-glued to inside face of CD



View of inside face of CD

glue pegboard with smooth side facing inward toward straw, to give minimum friction against straw

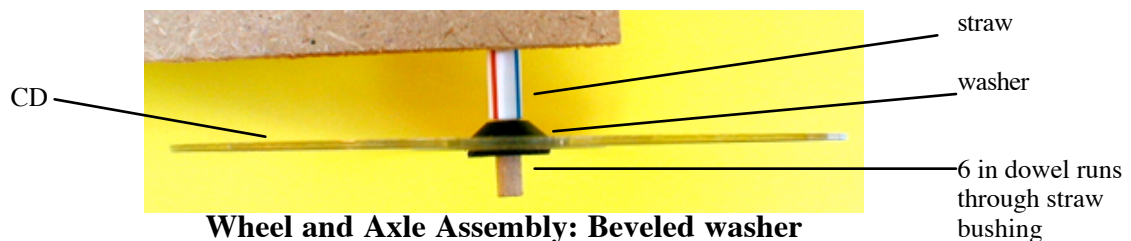
1 in x 1 in pegboard square with hole in middle -- hot-glue to CD -- adjust position of pegboard hub on axle so it doesn't rub against straw, but also doesn't allow excessive movement of axle back and forth



View of outside face of CD

rough side of pegboard visible through transparent portion of CD

the pegboard and the washer are alternate methods of mounting the wheel to the axle -- use whichever is available -- probably pegboard, since (a) it's cheaper, and (b) the washers are an odd size that can be hard to find

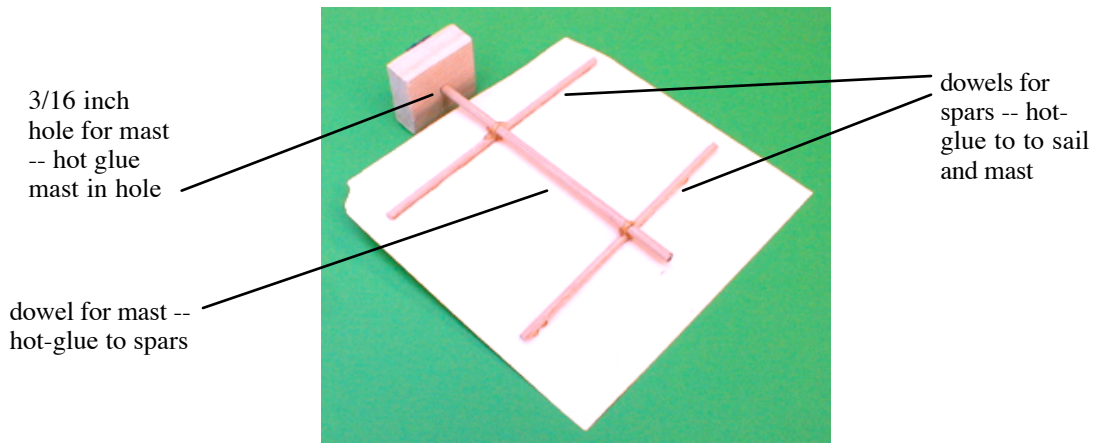


Wheel and Axle Assembly: Beveled washer

straw

washer

6 in dowel runs through straw bushing



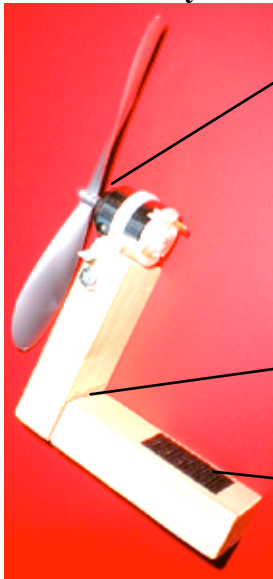
3/16 inch hole for mast -- hot glue mast in hole

dowel for mast -- hot-glue to spars

dowels for spars -- hot-glue to sail and mast

Sail Unit

Fan Assembly



use 1/16 inch drill to enlarge the hole in the propeller -- it will then slip tightly on the motor shaft

wood blocks hot-glued together

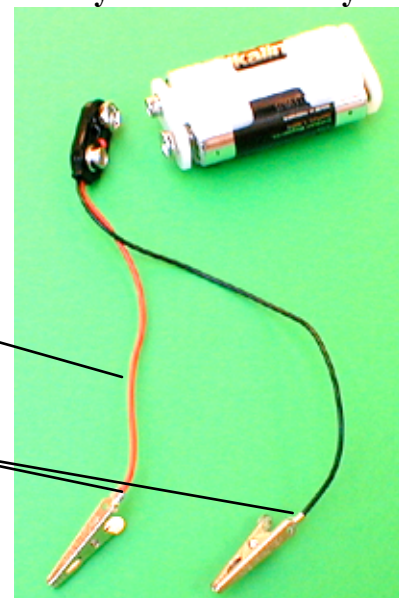
battery assembly attaches here

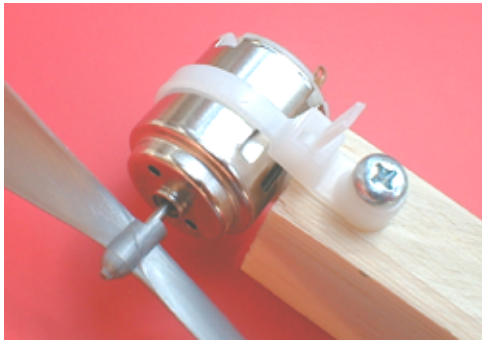
The **Kelvin** battery holder is a single unit with wire leads -- comments below on wire stripping and attaching alligator clips are also applicable to the **Kelvin** holder -- use whichever is available -- Kelvin is significantly cheaper, but not as convenient to obtain, since it has to be ordered

Radio Shack Battery Holder Assembly

before attaching alligator clips, cut one lead so that it's a little more than an inch shorter than the other -- this will help prevent the clips from touching each other and short-circuiting the batteries

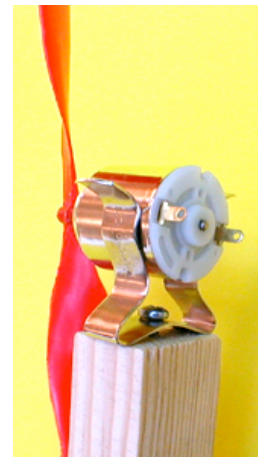
strip ends of leads and attach to alligator clips -- put end down through hole in alligator clip and back between tabs -- bend tabs down so wire is held tightly





**Motor Mount
Cable Tie (ZIP Tie)**

these are alternate methods for mounting the motor -- use whichever is available -- probably will be a cable tie, since it's far cheaper and also easier to get



**Motor Mount
Spring Clip Broom Holder**

To Do and Notice

1. Attach the sail to the cart, and attach the fan to the cart so that it will blow air toward the sail when it is running. Turn on the fan, and observe what happens.
2. Leave the sail in place, but remove the fan assembly and turn it around (or leave the fan assembly in place and reverse the electrical connections to the motor), so that the fan will blow air away from the sail when it is running. Turn on the fan, and observe what happens.
3. Remove the fan assembly, and hold it in your hand while it blows air toward the sail. Observe what happens.
4. Replace the fan assembly so that it will blow air toward the sail when it is running, but then remove the whole sail assembly. Turn on the fan, and observe what happens.
5. Return to the original situation, with the fan and sail both attached to the cart, and the fan blowing air toward the sail. Now insert a file folder or a stiff piece of paper between the fan and the sail, and observe what happens.

What's Going On?

Here is a summary of the results to be expected for the four situations above:

1. Cart doesn't move.
2. Cart goes forward.
3. Cart goes forward.
4. Cart goes backward.
5. Initially the cart doesn't move, but when the file folder or paper is in place, the cart moves backward.

The behavior of the cart is a classic example of Newton's Third law: For every action, there is an equal and opposite reaction.

In case 1, the fan pushes the air forward, and the air pushes the fan backward. (A crucial thing to keep in mind is that the action and reaction forces -- often called an action-reaction pair -- do not act on the same object.) If this was all that was happening, the cart would move backward; the fan is being pushed backward, and since it's attached to the cart, the cart would be pushed backward also. In fact, this is exactly what does happen in case 4, when the sail is not present. But in the present case, the sail is in place, so there is a second action-reaction pair, with the air pushing forward on the sail, and the sail pushing backward on the air. So in this case there end up being two forces exerted on the cart, i.e., the air pushing backward on the fan, and the air pushing forward on the sail. these two forces balance each other, and the cart doesn't move.

Try to identify the action-reaction pairs in cases 2, 3, 4 and 5 (actually, case 4 has already been done in the preceding discussion) and to use them to predict why the cart behaves as it does.

Confused? If you need help, let us know, and we'll be glad to go over things with you.