RAFT IDEAS

**Topics:** Motion, Momentum, Friction, Simple Machines

**Materials List**

- ✓ Skewers, bamboo, 2
- ✓ Box, lid, or plastic tray to use as a car body (width must be about ¼ less than length of a skewer)
- ✓ Foam, firm
- ✓ CD's, 4
- ✓ Double stick adhesive tape or equal
- ✓ Straw, giant jumbo (fast food size)
- ✓ Single hole punch or equal
- ✓ Hot glue gun and glue sticks may be needed
- ✓ Inclined plane

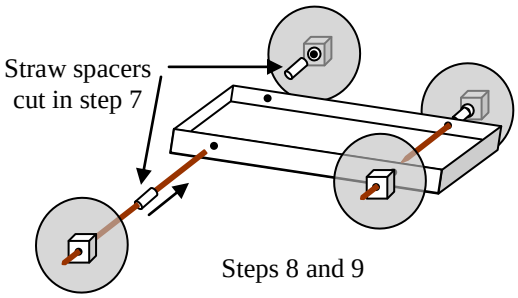
This activity can be used to teach:
Next Generation Science Standards:

- Forces & Motion (Physical Science, Grade 3, 2-1, 2-2; Middle School, 2-2; High School, 2-1)
- Kinetic & Potential Energy (Physical Science, Grade 4, 3-1; Middle School, 3-2, 3-5)
- Gravity (Grade 5, Physical Science 2-1)

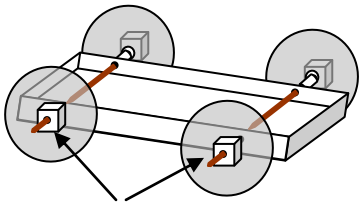
raft resource area for teaching
www.raft.net

# Cart the Box

## Making a cart or car from inexpensive materials




Steps 8 and 9

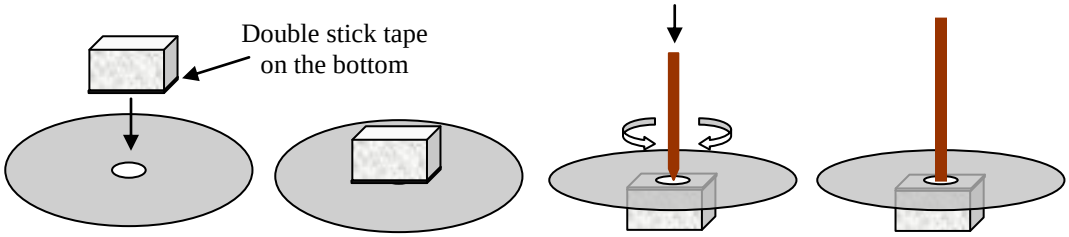


Apply hot glue to the area where the skewer comes out of the foam, repeat for each wheel (Step 11, if needed)

Learn about wheels and axles while making a vehicle that can really move!

**Assembly**

1. To make handling the skewers safer, aim the tips of the skewers toward a waste receptacle and cut off a bit of the pointed part to create a blunt tip.
2. Into the sides of a box, lid, or tray make 4 holes in the appropriate locations for 2 axles. Position the holes so the axles will be parallel (so the car rolls straight). Note that a 1 hole punch makes a 6 mm (1/4") or so sized hole. If another tool is used, to make the hole, then check that a skewer will turn freely when inserted.
3. Cut stiff foam to make 4 blocks where the longest dimension is roughly 1/3 the diameter of the CD. The blocks do need to be wider than the hole in the CD.
4. Put a section of double stick on 1 side of a block, remove the release paper and press a foam block onto each CD as shown in the illustrations on the left below.
5. Turn the CD so the foam side is downward and place on a suitable work surface. At the center of the CD insert and twist back and forth the blunt tip of a skewer, going straight down into the foam. See the 2 illustrations below and to the right.




6. Remove the skewer and repeat step 5 for the other 3 CD's and foam blocks.
7. Cut 4 straw pieces about 1-1/2 cm (5/8") long from a straw that has a larger diameter than the punched holes (e.g., fast food straw).
8. Insert a skewer into the hole in a foam block, starting from the CD side, and Put a cut straw section, from step 7, over the exposed long end of the skewer and then insert the long end of the skewer into an axle hole made in the box.
9. Push the long end of the skewer through the opposite axle hole, add another cut straw section to the skewer, and then insert the skewer into another foam block starting from the CD side. Repeat for the other 2 CD's and last pair of axle holes. (See the illustration at the top of the page, on the left, showing steps 8 and 9.)
10. Adjust the position of the CD's so that the CD's are able to spin freely.
11. If the CD's need to be more securely attached to the foam or skewers then apply hot glue to the junctions between the skewer/foam and/or foam/CD on the foam side of each CD. If a skewer does not protrude out the side of the foam block cut the foam block enough to expose the end of the skewer for gluing.

Created and written by Michael Pollock (RAFT)

## To Do and Notice

1. Position the cart at the top of an inclined plane and release. Repeat several times and find the average distance traveled from the end of the inclined plane to where the cart stops moving. Always start the cart at the same point.
2. Change the angle of the inclined plane, repeat tests, and record results.
3. Record the cart's mass. Add weights to the cart and observe the distance travelled.
4. Cover the inclined plane with different materials and repeat steps 1-3 to explore how changes in surface friction can affect the distance traveled by the cart.

## The Science Behind the Activity

A wheel and axle consists of two circular objects of different diameters, with the larger diameter wheel turning around the smaller diameter axle. A cart is slowed by the rotating friction of the axles rubbing in the axle holes cut into the car body and the sliding friction between the wheels and the surface underneath. For each rotation the axle travels a shorter circular distance than the wheel. The shorter turning distance of the axle means less energy is lost to friction than if the axle and wheel had the same diameter. Many techniques have been developed to reduce the friction of the rotating axles including coating the axles with grease and adding bearings that surround the axle with even smaller rotating parts. The friction from an axle rotating in bearings is much less than the friction of an axle rotating in a hole or sleeve fixed to the car body.

The wheel and axle combination is one of the six simple machines. The others are the lever, wedge, pulley, inclined plane, and screw. Simple machines can make a task easier by changing the size and/or the direction of the input force required to do a task.

## Taking it Further

- Add a mousetrap or other device that will store potential energy and can convert the energy into motion.
- Use the cart in a design challenge. Begin with the basic design, and then challenge students to make improvements by changing a design feature (e.g., materials, dimensions, loads).
- Explore different methods to reduce the friction of the rotating axles. Experiment with different lubricants such as soap, graphite from a pencil, or vegetable oil.
- Investigate how the distance traveled is affected by changing the wheel diameters, or by having a smaller pair of wheels in the front of the cart.

## Web Resources (Visit www.raft.net/raft-idea?isid=544 for more resources!)

- Invention of the wheel - http://www.ancient-origins.net/ancient-technology/revolutionary-invention-wheel-001713
- Designing and building a mousetrap car - http://www.pbs.org/saf/1208/teaching/teaching.htm