Marshmallow Puff Tube

If you blow harder, will it go farther?

Experiment with cardboard tubes of different lengths to see how far you can blow a marshmallow.

Mechanics

materials

- ✔ 1 file folder (or other lightweight cardboard)
- ✔ scisors
- ✔ masking tape or transparent tape
- ✔ a few marshmallows (full-size, not miniature)
- ✔ a few spoonfuls of flour

assembly

Cut a rectangle from the file folder about 29.5 cm (the entire width of an unfolded file folder) by about 19 cm (11.5 in. by 7.5 in.).

Place one of the long edges of the file folder inside the other, and tighten to form a tube (see Figure 1) that fits around the circular shape of a marshmallow - snug enough so that there's no air space around the marshmallow, but not so tight that the marshmallow won't be able to move. It may be easier to make the tube if you first pull the folder over the edge of a table to establish an initial curvature.

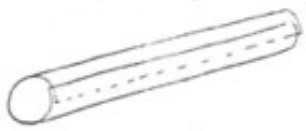

Figure 1

When the tube is rolled to the appropriate size, tape it so it maintains this size. Then place tape along the entire length of the seam on the tube to seal it.

to do and notice

1. Roll the marshmallow in flour, then shake it or tap it to remove any excess. The flour will help prevent any sticky spots on the marshmallow from sticking to the tube.

2. Place the marshmallow in the end of the tube. Holding the tube horizontally, put your mouth over the empty end, and blow hard into the tube (see Figure 2). Notice how far the marshmallow goes.

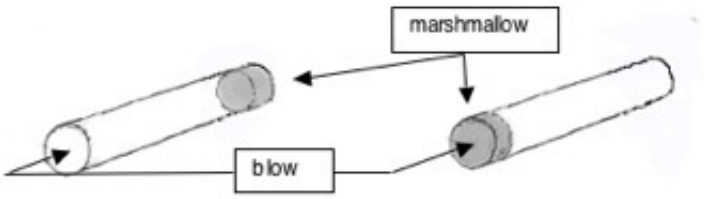

Figure 2 Figure 3

3. Again place the marshmallow in the end of the tube, but this time put your mouth around the end of the tube where the marshmallow is located. Blow hard against the marshmallow itself, so that it has to travel the length of the tube before exiting (see Figure 3). Be sure to keep the tube horizontal, and keep blowing the whole time the marshmallow is in the tube. Did the marshmallow go farther this time?

If you blow and the marshmallow won't move, check the diameter of the tube. The tube may either be too tight (in which case friction prevents it from moving) or too loose (in which case air blows right by the marshmallow instead of pushing it).

what's going on?

While the marshmallow is in the tube, your blowing increases the air pressure in the tube, creating a force on the marshmallow. As long as this force is greater than the friction force, there's an unbalanced force on the marshmallow. According to Newton's second law, F = ma, an unbalanced force accelerates an object. The speed of the marshmallow will keep increasing for as long as the marshmallow experiences an unbalanced force.

As soon as the marshmallow leaves the tube, your blowing no longer affects it. But the faster the marshmallow is traveling when it leaves the end of the tube, the farther it will travel before hitting the ground.

In the first case, with the marshmallow initially placed at the far end of the tube, the marshmallow falls out the end of the tube almost as soon as you blow on it. So the unbalanced force on it doesn't last very long, and the marshmallow doesn't get going very fast or travel very far.

In the second case, when you blow the marshmallow the length of the tube, it experiences an unbalanced force for the entire length of the tube. Since the force acts for a longer time, the marshmallow is going faster when it leaves the tube, and it therefore travels farther.

The length of tube that will provide maximum speed is really determined by how long you can keep blowing strongly enough to maintain enough pressure in the tube so that the force produced on the marshmallow is larger than the friction force. If you have really big lungs, you can use a very long tube, and get the marshmallow moving really fast!

etcetera

Try using a significantly longer tube - double or triple the length of the file-folder tube.

Try elevating the tube at different angles above the horizontal to see the effect on range.

What's the absolute maximum range you can achieve for the marshmallow? What combination of tube length and elevation gives this range? Do the results vary from person to person?

Challenge: Speed and Range of a Marshmallow Projectile

The photo below was taken by Dean Baird during a demonstration session by Don Rathjen and Paul Doherty at the fall meeting of the Northern California-Nevada American Association of Physics Teachers at Gunn High School, Palo Alto, California, on November 6, 2005.