Marshmallow Puff Tube

If you huff and you puff
You can blow a marshmallow far enough
To qualify as amazing stuff

Materials

1 manila file folder
1 empty cardboard toilet paper tube
scissors
masking tape and/or translucent tape
a few marshmallows (full-size, not miniature)

Assembly

Cut the file folder in half (parallel to the fold). When you cut, remove any creases or scorings associated with the fold, as well as any file tabs. The piece you end up with should be a rectangle.

Cut the toilet paper tube down its length.

For both the manila folder and the toilet paper tube, place one of the cut edges 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. (The file folder should be rolled so that it forms a long tube, not a short tube. Also, for the file folder it may be helpful to run the folder over the edge of a table to establish an initial curvature. This may make it easier to roll the tube.) Tape each tubes so it maintains this size. Also place tape along the entire length of the seam on each tube to seal it.

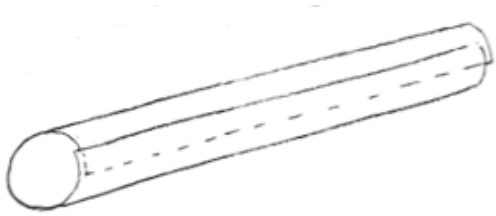

Figure 1

To Do and Notice

1. Place the marshmallow in the end of the toilet paper tube. Hold the tube horizontal, put your mouth over the empty end, and blow hard into the tube (see Figure 2). Notice how far the marshmallow goes.

2. Again place the marshmallow in the end of the toilet paper 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 hold the tube horizontal, and keep blowing the whole time the marshmallow is in the tube. Did the marshmallow go farther this time?

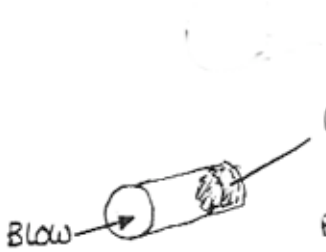

Figure 2

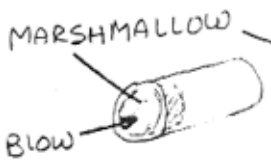

Figure 3

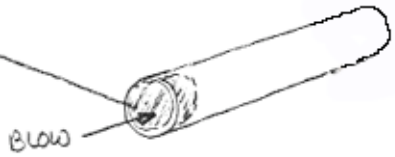

Figure 4

3. Now place the marshmallow in the end of the file folder tube. Blow directly against the marshmallow, so that it has to travel the length of the tube before exiting (see Figure 4). Be sure to hold the tube horizontal, and keep blowing the whole time the marshmallow is in the tube. How far did the marshmallow go this time?

HELPFUL HINTS: If you blow, and the marshmallow won't move, try adjusting the diameter of the tube. The tube may be either 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). If the marshmallow is sticky, try rolling it in a little flour. If possible it's a good idea to open the bag of marshmallows a day or more before you plan to use them, separate them, and let them dry out a little.

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What's Going On?

While the marshmallow is in the tube, your blowing raises the air pressure in the tube, creating a force on the marshmallow. As long as this force is greater than the friction force, the marshmallow will accelerate, and its speed will keep increasing. As soon as the marshmallow leaves the end of the tube, your blowing no longer affects it. The faster the marshmallow is traveling when it leaves the end of the tube, the farther from the end of the tube it will travel before hitting the ground.

In the first case, with the marshmallow initially placed at the far end of the toilet paper tube, the marshmallow falls out the end of the tube almost as soon as you blow on it. So the 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 whole length of the toilet paper tube, it experiences the 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.

In the third case, when you blow the marshmallow the whole length of the file folder tube, the tube is significantly longer than the toilet paper tube. The marshmallow experiences force for a longer time, giving it a higher speed and a dramatically longer distance.

The length of tube which will give 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!

Going Further

Try elevating the tube at different angles above the horizontal to see the effect on range. Try blowing the marshmallow straight up.

Try two file folder tubes taped together. Place the second half of the file folder around the outside of one end of the tube you have already taped, with about an inch of overlap (about an inch of the **first** tube should be **inside** the second tube). Tighten it until it fits around the first tube. Tape the second tube so that it maintains this size (it should have a diameter very slightly larger than the first tube), and tape it securely to the first tube so that the two tubes taped together form a single straight tube with about an inch overlap in the middle (see Figure 5). Be sure that tape has been placed along the entire length of the seams on both tubes, and around the seam where they overlap, so that air can't leak out at the seams.

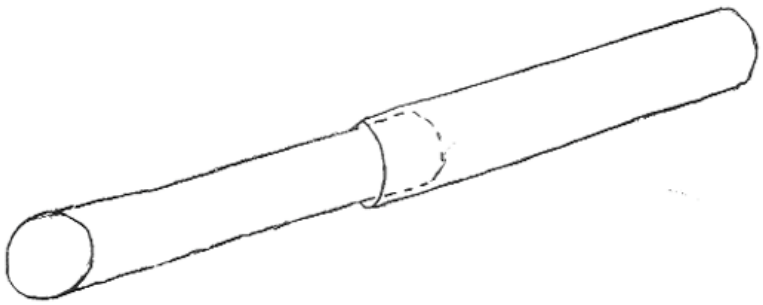

Figure 5

What is 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?

See **Speed and Range of a Marshmallow Blowgun** on page 3.

References

• Baird, Dean, **The Blowgun as a Teaching Tool**, The Physics Teacher, February 1996, pp. 98-100.
• van den Berg, Ed, Jover Nunez, Alfredo Guirit, **Cotton Buds, Momentum and Impulse**, The Physics Teacher, January 2000, pp. 52-53.

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Speed and Range of a Marshmallow Blowgun

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 AAPT, at Gunn HS, Palo Alto, Nov 6, 2005.

Here is Dean's caption for the photo on the NCNAAPT website:

> **Marshmallow Blowgun.jpg**
> **Iron Physics Teacher Challenge: The exposure was 1/30th of a second. Estimate the speed and range of the marshmallow. Please take the non-zero launch height into consideration.**

As a more straightforward initial challenge, can you use simple measurements on the photo, and the time of exposure, to determine the speed of the marshmallow at the time the photo was taken? Helpful Hint: The blowgun itself is made from half of an ordinary file folder rolled into a tube.

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