

# DIY Face Mask Material Testing

by [MakerMask.org](https://makermask.org)



# Contents

---

1. Overview
2. Preparation
3. Results Table
4. DIY Droplet Protection Test
5. DIY Breathability Test
6. DIY Particle Filtration Test
7. Conclusion





# Overview

---

- ❖ Industry standard testing for face masks as personal protective equipment (PPE) is comprised of five (5) tests:
  1. Breathability
  2. Water penetration
  3. Particle filtration
  4. Flammability
  5. Comfort and fit
- ❖ These tests are complex and there are no simple replacements, but for the first three (3), there are safe and simple tests that can be performed at home to demonstrate the core principles of each test.



# Preparation

---

The items listed below will be needed for all the following tests. Additional items required for a specific test will be included in each test section.

## Materials to test:

- ❖ Cut a 4" (10.1cm) square of each material
- ❖ Paper towel
- ❖ Cotton fabric
- ❖ Nonwoven polypropylene (NWPP)
- ❖ Plastic wrap

## Tools and other supplies:

- ❖ Scissors
- ❖ Clock, timer, or stopwatch
- ❖ Elastic or rubber bands
- ❖ 4x Cardboard tubes (from toilet paper rolls)
- ❖ Yard stick or tape measure
- ❖ Pea-sized lint ball or cotton ball
- ❖ The results table on the next slide
- ❖ A flat clear surface to work on



# Results Table

---

- ❖ Use the table below (print out this slide or double click table to enter values directly) for recording the results of each test.

	DIY test					
Material	Droplet protection			Breathability		Particle filtering
	Water at start	Water in glass	Rank	Distance	Rank	Rank
Paper towel						
Cotton cloth						
NWPP						
Plastic wrap						

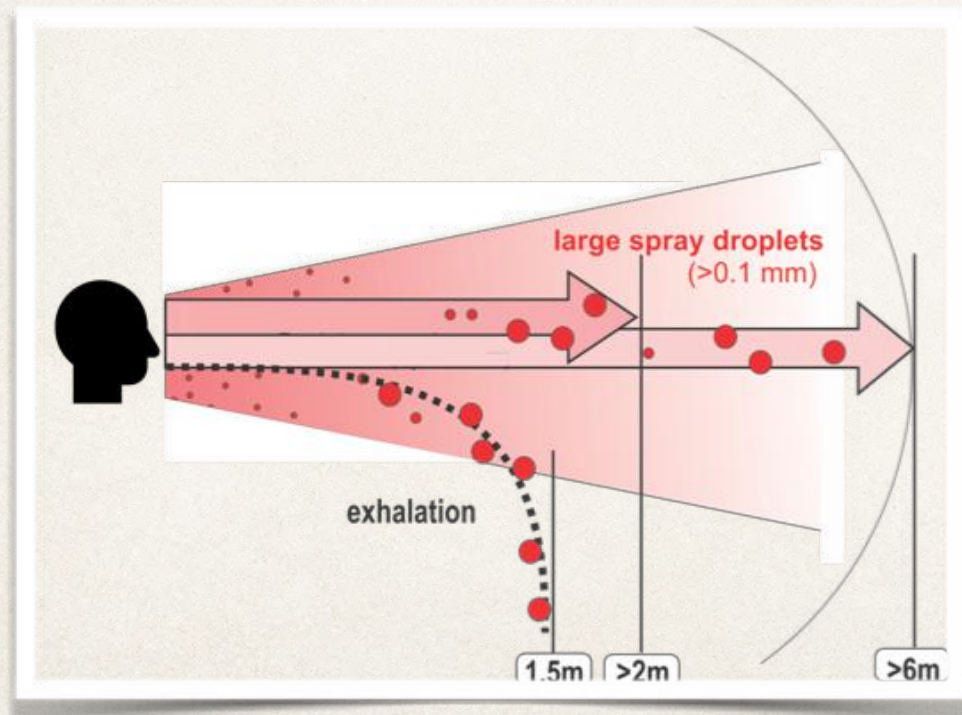


# DIY Droplet Protection Test: Overview

---

Why is it important?

The core principle of this test is to determine if a material is suitable to use as a barrier against water droplets.



Tools and supplies for this test:

- ❖ A glass or jar
- ❖ A measuring cup
- ❖ A device to measure water (syringe, pipet, teaspoon, etc)
- ❖ A graduated medicine cup



# DIY Droplet Protection Test:

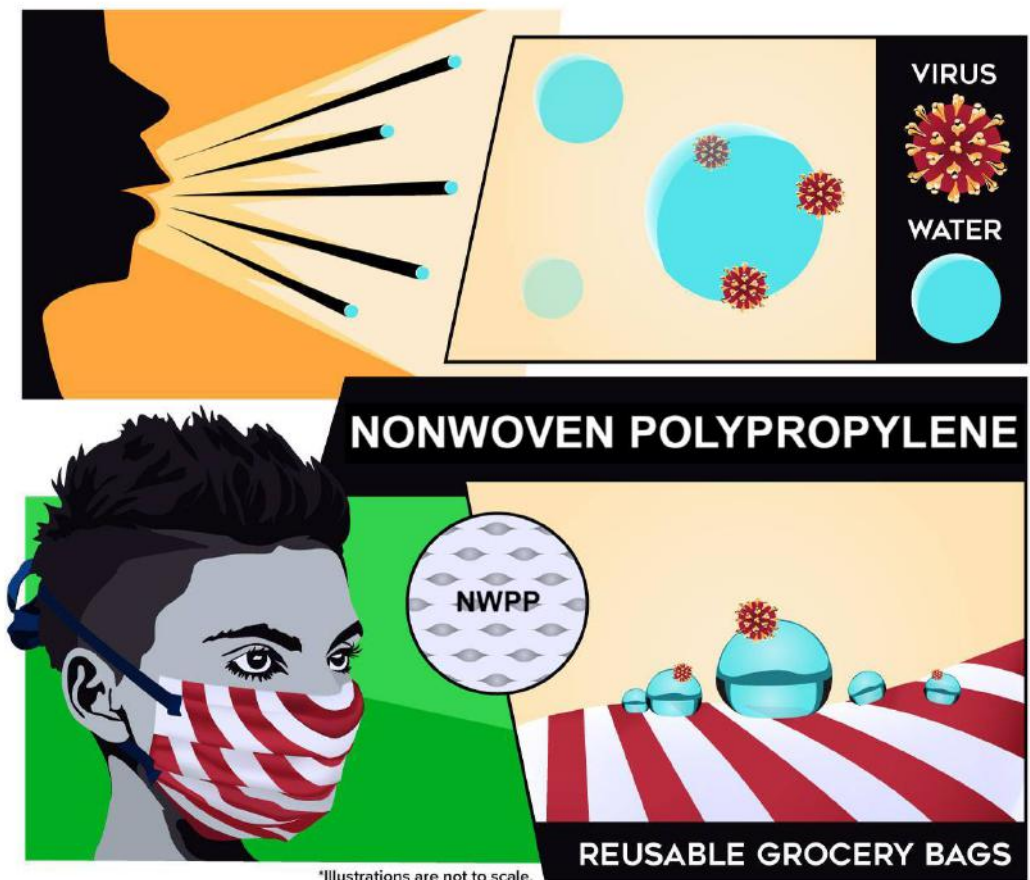
## Objective

Materials that are *hydrophobic* (repel water) are ideal for use as a barrier from droplets. Use this test to determine how well a material can protect from water.

*Hydrophobic* :: a property of a material that allows it to repel water from its surface; think of the phrase “beads of water”

*Hydrophilic* :: a property of a material that will cause water to spread out on its surface; think of what happens to a piece of paper when water is poured onto it

### BENEFITS OF WATER-RESISTANT MATERIALS IN MASK PRODUCTION



For science-based mask designs to help combat the spread of COVID-19, visit:

**MAKERMASK.ORG**  
@themakermask

4MAY20



# DIY Droplet Protection Test: Objective

---

1. On your clear work space, set out the four materials for testing, elastic bands, and an empty glass.
2. Fill a measuring cup with room temperature water and bring back to your work space.
3. Take one of the squares of material, place over the mouth of the empty glass, and place the elastic band around the rim of the glass to hold the material in place.
4. Measure 5-10 mL or 1-2 (US) teaspoons of water, and pour onto the material covering the glass.

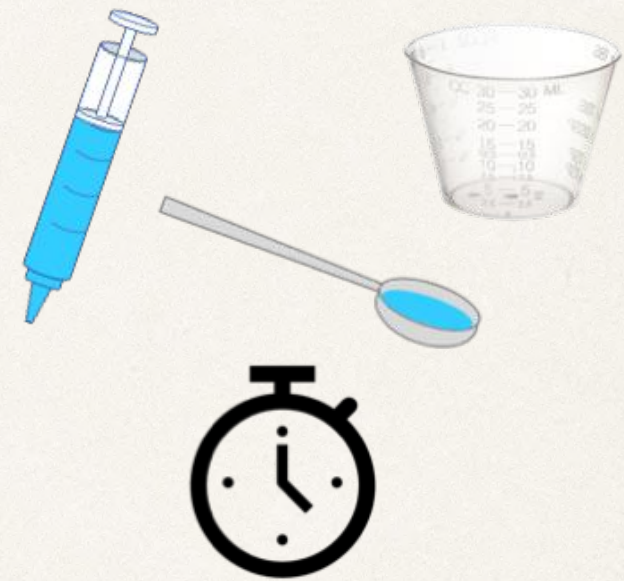




# DIY Droplet Protection Test: Objective

---

5. Set a timer for 60 seconds after pouring the water on top of the material
6. When the timer is completed, carefully remove the material from the mouth of the glass and pour off any excess water (materials with more excess water are likely hydrophobic).
7. Pour any water inside of the glass into a graduated medicine cup and record the amount of water in your results table.
8. Dry off the inside of the glass, and repeat the process with each material.





# DIY Droplet Protection Test: Setup & Procedure

---

Here is an example of test results for the materials listed.  
Notice how these results compare to yours.

	DIY test					
Material	Droplet protection			Breathability		Particle filtering
	Water at start	Water in glass	Rank	Distance	Rank	Rank
Paper towel	10 mL	1.2 mL				
Cotton cloth	10 mL	4.0 mL				
NWPP	10 mL	0.0 mL				
Plastic wrap	10 mL	0.0 mL				



# DIY Droplet Protection Test:

## Discussion

---

### Conclusion

- ❖ Of the four materials tested, notice which ones allowed the least amount of water into the glass. These materials block water and should be ranked highest in your results table.
- ❖ Based on the results, which material would be more suitable as a barrier against water droplets?

### FOR SCIENCE! (deeper dive)

- ❖ If you have a scale, you could also measure the weights of each material before and after the test, to see which absorbed the most water.
- ❖ One test is never enough. If you have more of the materials to use, repeat the tests (or wait until each one is dry). See if you can determine if your first results are consistent.
- ❖ Curious to know how other materials may perform? Try some!



# DIY Breathability Test: Overview

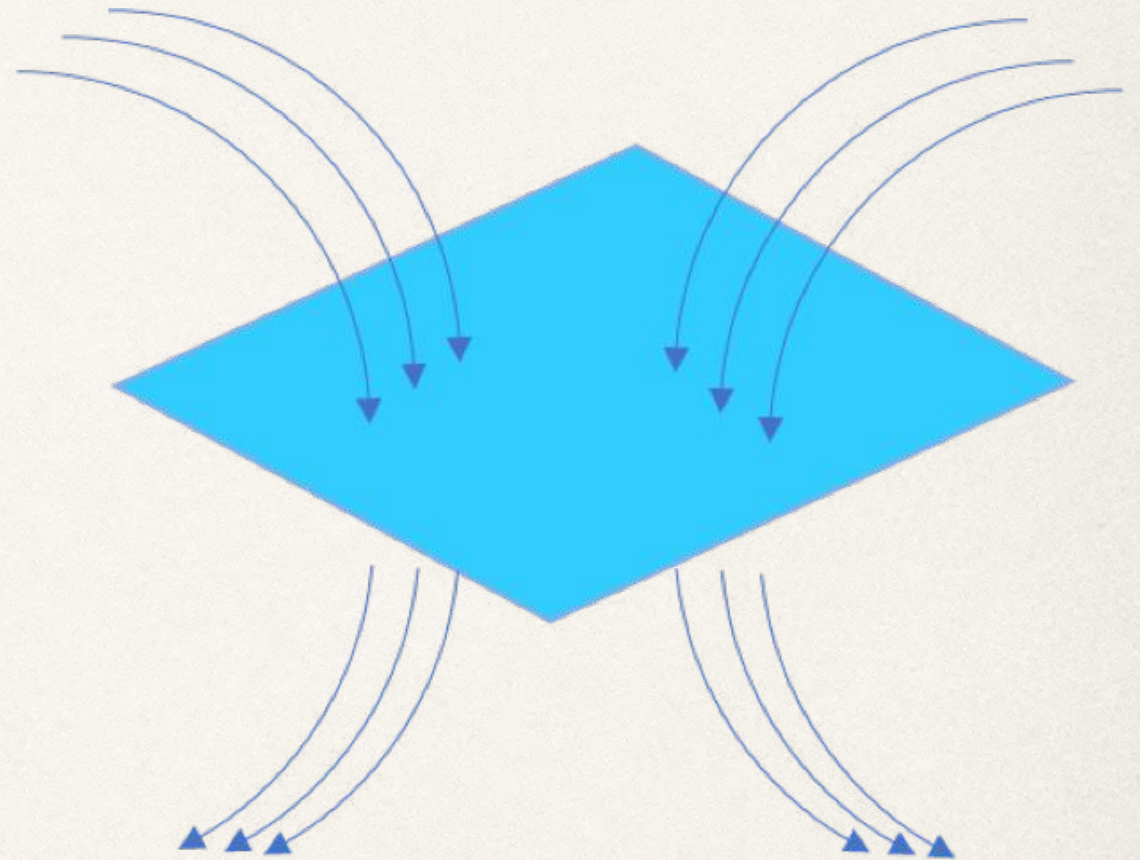
---

What is a breathability test?

- ❖ A breathability test measures how difficult it is for someone to breathe, specifically while wearing a mask.

Why is it important?

- ❖ Breathing tests are used to determine what materials will allow for people to breathe comfortably while wearing a mask. If breathing is uncomfortable while wearing a mask, a person may be more likely to loosen the mask, reducing the mask's protective filtering effectiveness .





# DIY Breathability Test: Objective

---

Materials that pass the breathability test will be more comfortable to wear, especially for extended periods of time. Use this test to determine which material is most breathable by measuring how far a small object can move.

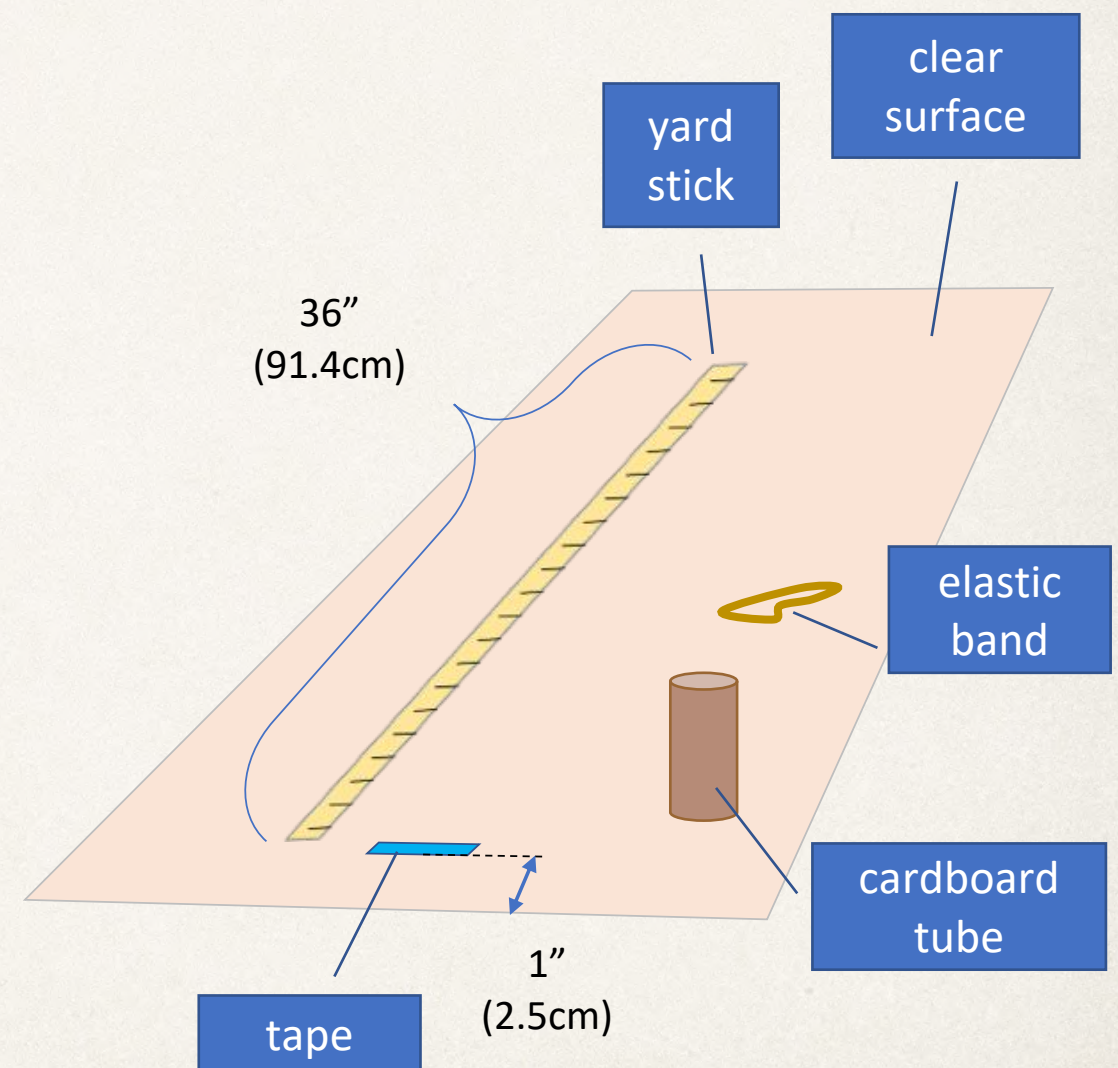
Tools and supplies for this test:

- ❖ A glass or jar
- ❖ A measuring cup
- ❖ A device to measure water (syringe, pipet, teaspoon, etc)
- ❖ A graduated medicine cup



# DIY Breathability Test: Overview

1. With the space cleared on a flat surface, place a strip of masking or painters tape on the surface (at least 1" or 2.5 cm from an edge) and set your measuring device next to it so that the zero-marker is aligned with the far edge of the tape.
2. Wrap each square of material over one end of a cardboard tube (four tubes in total), and secure it with an elastic band.
3. Find some lint, cotton ball, or cotton swab and roll it into a ball that is about the size of a pea.

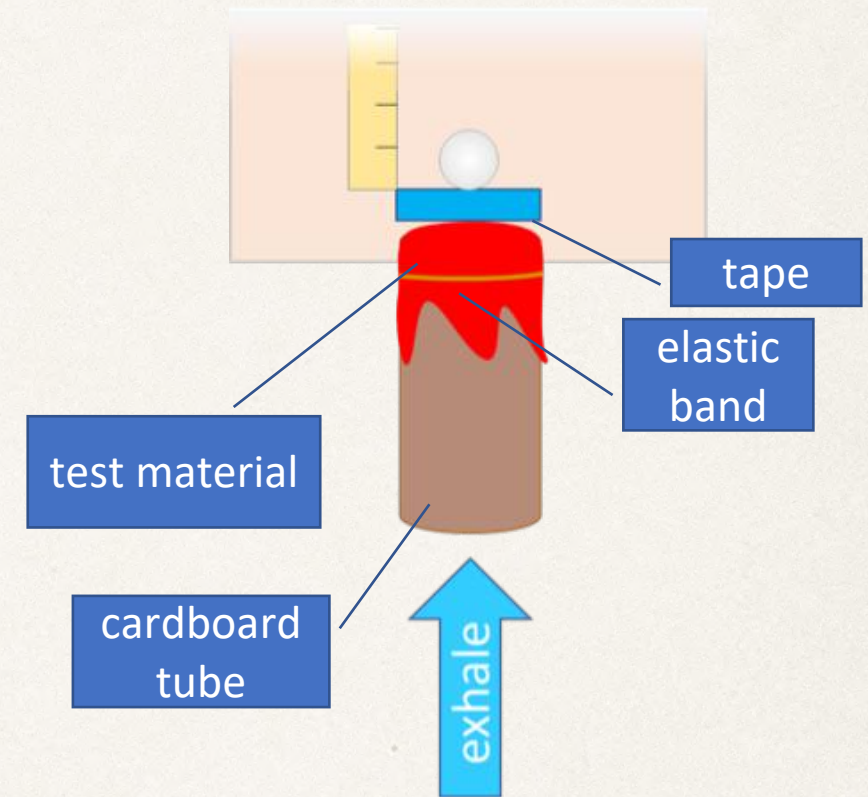




# DIY Breathability Test: Overview

---

4. Place the cotton or lint ball on the far edge of the tape (starting at zero on your measurement device).
5. On the near side of the tape, set the end of the cardboard tube wrapped with material.
6. Using one normal breath, blow through the tube, trying not to move your head.
7. Once your breath is finished, measure the distance from the start edge of the tape to where the ball stopped.
8. Record this distance in your results table.
9. Replace the ball at the zero-marker and repeat for each material; do this until you've completed the test with all materials.





# DIY Droplet Protection Test: Setup & Procedure

---

Here is an example of test results for the materials listed.  
Notice how these results compare to yours.

	DIY test					
Material	Droplet protection			Breathability		Particle filtering
	Water at start	Water in glass	Rank	Distance	Rank	Rank
Paper towel	10 mL	1.2 mL		1"		
Cotton cloth	10 mL	4.0 mL		1.5"		
NWPP	10 mL	0.0 mL		1"		
Plastic wrap	10 mL	0.0 mL		0"		



# DIY Breathability Test: Discussion

---

## Conclusion

- ❖ Of the four materials tested, notice which ones allowed the ball to travel the farthest, these materials have a high breathability.
- ❖ Notice that now from the although plastic wrap performed very well in the droplet test, since it fails the breathability test, it shouldn't be considered as a suitable material for a face mask (of course!).

## FOR SCIENCE! (deeper dive)

- ❖ One test is never enough. Repeat the test multiple times and take the average of the distances for each material to see if you can determine if your first results are consistent.
- ❖ Curious to know how other materials may perform? Try some!

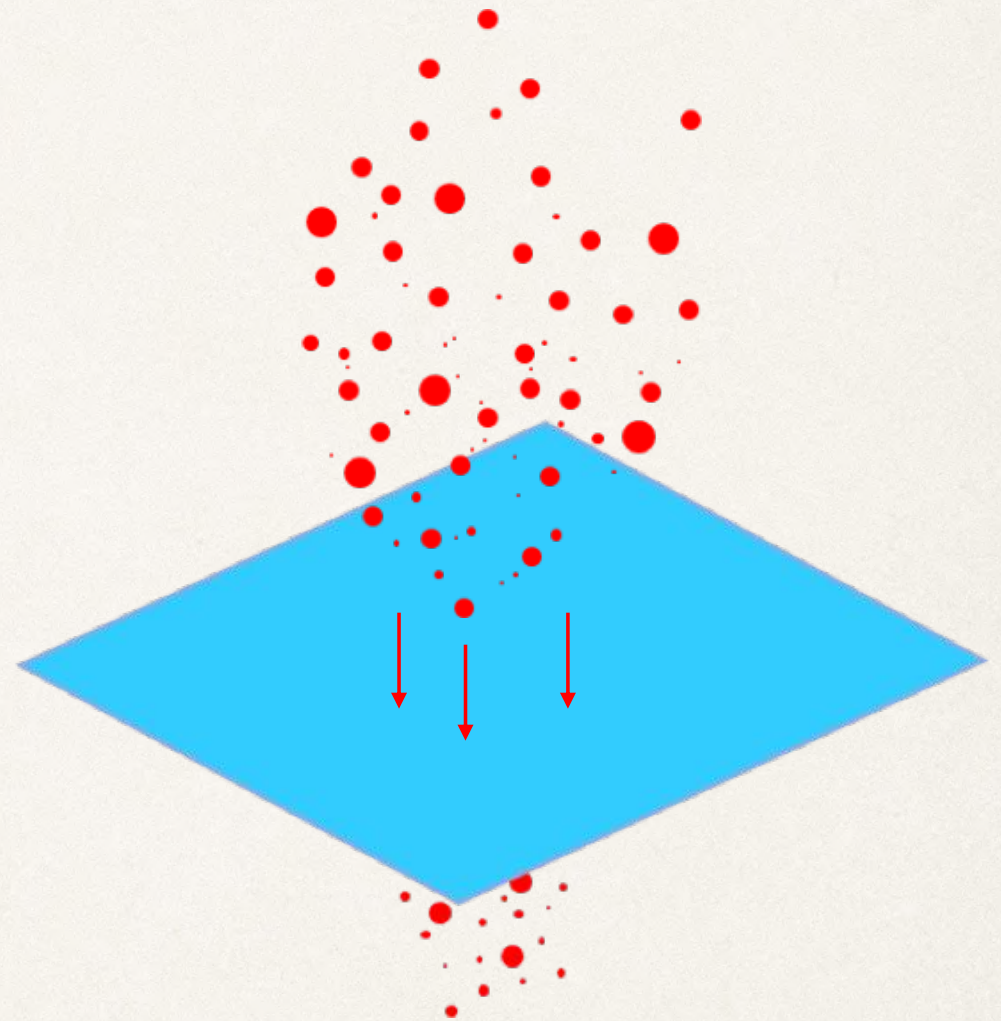


# DIY Particle Filtration Test: Overview

---

Why is it important?

In addition to adequate droplet protection, material particle filtration is an important aspect when considering how to make an effective barrier.





# DIY Particle Filtration Test:

## Objective

---

Materials with a high capacity for particle filtration are those that prevent or significantly reduce the number of particles passing through the material. Use this test to determine which material reduces or blocks the most amount of particles from passing through.

Tools and supplies for this test:

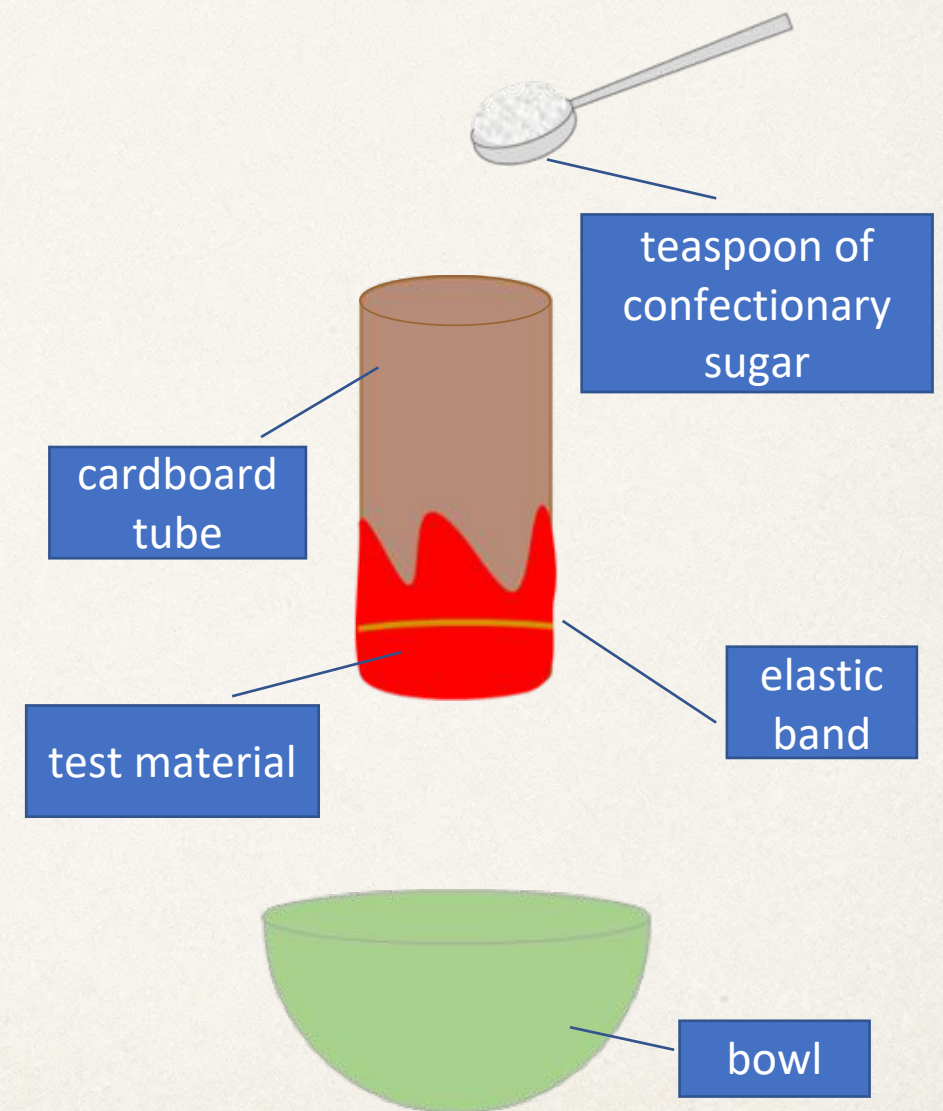
- ❖ Confectionary sugar
- ❖ A US teaspoon
- ❖ A bowl or pan



# DIY Particle Filtration Test: Setup & Procedure

---

1. You will reuse the same cardboard tubes wrapped in material from the Breathability Test
2. Setup your test area with a bowl to work over (to avoid any potential mess), a US teaspoon, and some confectionary sugar.
3. Hold the first cardboard tube with material over top the bowl, so that the end with the material is facing downwards.
4. Scoop one teaspoon of confectionary sugar into the open end of the cardboard tube.

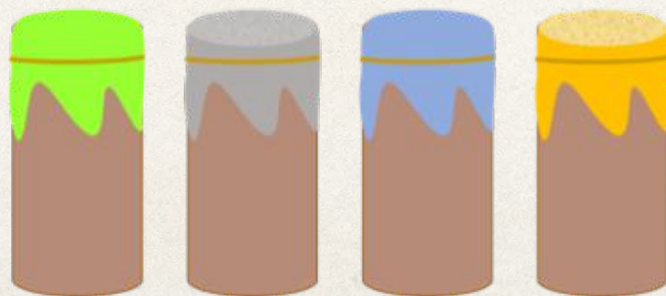




# DIY Particle Filtration Test: Setup & Procedure

---

5. Using a timer, agitate the tube with sugar for 30 seconds above the bowl
6. After agitating for 30 seconds, dump the excess sugar into the bowl, set the tube on a flat surface with the material facing upwards, and repeat the process with the remaining materials.
7. Once you have completed the test with each tube and material, observe how much sugar has passed through each material and record a rank for each material in your results table.



example of low  
particle filtering



example of high  
particle filtering



# DIY Particle Filtration Test: Results

---

Here is an example of test results for the materials listed.  
Notice how these results compare to yours.

	DIY test					
Material	Droplet protection			Breathability		Particle filtering
	Water at start	Water in glass	Rank	Distance	Rank	Rank
Paper towel	10 mL	1.2 mL		1"		
Cotton cloth	10 mL	4.0 mL		1.5"		
NWPP	10 mL	0.0 mL		1"		
Plastic wrap	10 mL	0.0 mL		0"		



# DIY Particle Filtration Test:

## Discussion

---

### Conclusion

- ❖ Which material did you find most breathable?
- ❖ Why do you think this happened?
- ❖ Do you think that the most breathable material is likely to offer proper filtering protection? Why or why not?
- ❖ What other materials or configurations do you think might be good to test (coffee filter or double stacked materials)?

### FOR SCIENCE! (deeper dive)

- ❖ One test is never enough. Repeat the test multiple times and take the average of the distances for each material to see if you can determine if your first results are consistent.
- ❖ Curious to know how other materials may perform? Try some!



# DIY Face Mask Materials testing:

## Conclusion

---

- ❖ It's important to take note of how each material performed for in all tests (not only one). For example, cotton is very breathable, but how does that change when it's exposed to water? If instead of using dry sugar, we used sugar diluted in water, do you think more or less particles would be filtered by a material?
- ❖ The evaluations of materials for use in making face masks are complex, but rooted in rigorous scientific principles. The DIY tests outline here are designed to demonstrate the core principles of those tests so you may make a better informed decision about which material is more suited for use as a DIY facemask.
- ❖ For more information, please visit [www.makermask.org](http://www.makermask.org).