Cleaning the Air

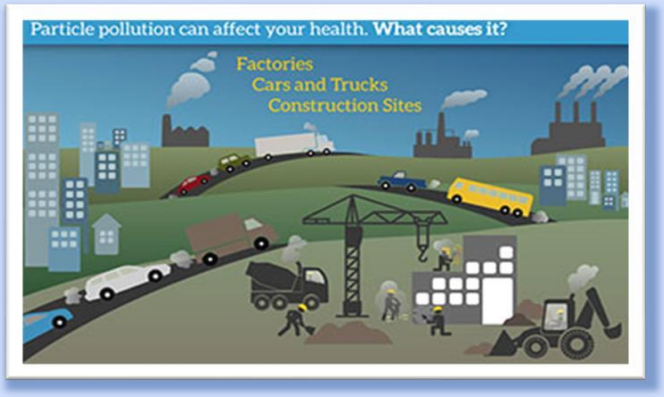
Outdoor air quality has improved since the 1990s, but many challenges remain in protecting Americans from air quality problems. Ground-level ozone, the main part of smog, and **particle pollution** are just two of the many threats to air quality and **public health** in the United States.

Terms to Know

Air filter (filter)	a **filter** that removes particles and impurities from the air
Citizen scientist	people — young or old — who help collect data for research projects conducted by professional scientists
Emissions	something that has been released into the world, particularly the air
Exposure/expose	to leave without protection, shelter, or care; subject to a harmful condition
Lead	a metal that is poisonous to humans that is used in a variety of products
Particle pollution	pollution caused by small bits of matter in the air
Public health	the science of protecting and improving the health of people and their communities

Understanding Particle Pollution

Particle pollution — also called particulate matter (PM) — is made up of particles (tiny pieces) of solids or liquids that are in the air. These particles include: dust, dirt, soot, metals, smoke, and drops of liquid. Some particles are big enough (or appear dark enough) to see — for example, you can often see smoke in the air. Others are so small that you cannot see them in the air.



Think About It

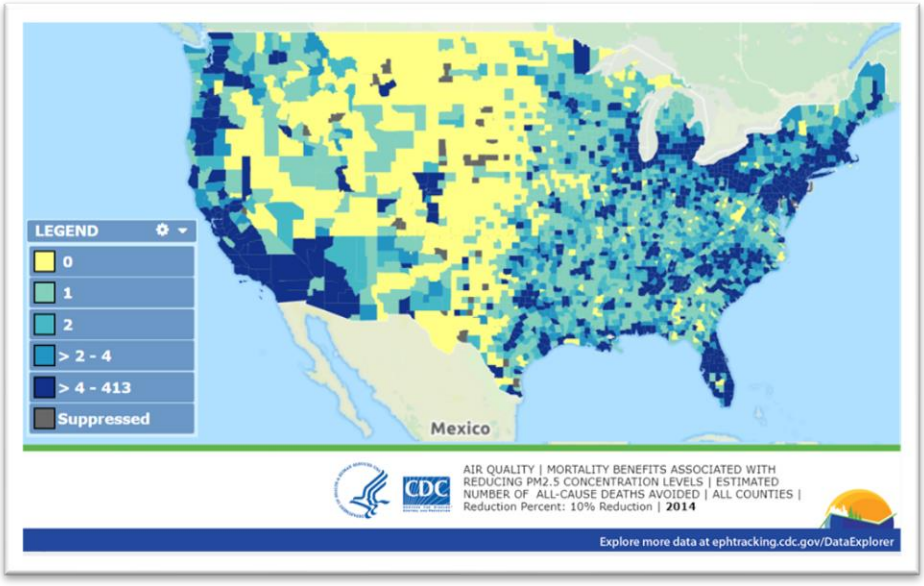
1. What types of particles are found in **particle pollution**?
2. Look at the image above. What causes **particle pollution**?
3. Why is **particle pollution** dangerous?

Particle Pollution and the Centers for Disease Control and Prevention (CDC)

Humans have caused air pollution since they discovered fire two million years ago. However, before the Industrial Revolution, the impact of this pollution was not enough to cause **public health** crises. In the 1800s, scientific innovations allowed societies to move away from farming and into the bustling cities we know today. Thanks to the creation of factories, new communities were developed with populations much larger than ever before. The use of chemicals and fossil fuels skyrocketed, filling the air with a dangerous mix of particulate matter/**particle pollution** that increased over time.

By the mid-20th century, scientists and health officials in the United States began to take notice of the toll air pollution had on communities near factories. Residents in these industrialized cities were experiencing severe problems with their hearts and lungs, leading to death in some cases. Scientists began investigating the connection between air pollution and health. They found that in communities where people were **exposed** to high levels of air pollution, a disproportionate number of residents experienced health problems. Much of this pollution came from the **emission** of small bits of metal, like **lead** and steel, into the air. Scientists and other concerned citizens began calling for government interventions to reduce the amount of pollution put in the air.

In 1970, the federal government answered the call by creating the United States Environmental Protection Agency (EPA). This agency's job is to monitor the effects humans have on the environment and to advise the government on policies to protect both citizens and the environment. The EPA teamed up with other government agencies and units, including CDC, to provide the federal government with comprehensive plans for protection against dangerous air pollutants.



For its part, CDC created tracking and monitoring programs that keep the public up to date on the levels of **particle pollution** within communities and the effect those levels have on **public health**. Together, the organizations work with state and local level health officials to design air pollution prevention plans for communities across the United States.

Think About It

1. How long have humans contributed to **particle pollution**?
2. What effect did the Industrial Revolution have on **particle pollution**?
3. How does CDC support efforts to reduce **particle pollution**?

From the Expert:

CDC has supported the efforts of communities to reduce their amounts of air pollution through the creation of CDC's Environmental Public Health Tracking Network. See how the Massachusetts Tracking Program worked with local health officials to protect air quality in Norwood with the arrival of a new asphalt plant. https://youtu.be/9BVydjpKRH8

Call to Action

As a **citizen scientist**, you can assist CDC in reducing the amount of air pollution in communities by following these three steps:

1. **Conduct an air particle observation.** How clean is the air in your home? Is it as clean as the air outside? A simple observation will allow you to determine what particles float in the air in your home.

2. **Build an air filter. Air filters** keep our homes safe by removing some of the particle pollutants in our air. Your **air filter** design can help inform your peers of the considerations environmental engineers make when designing **filters** for homes and businesses. Your design process can also help CDC educate other students about the steps necessary to create quality **filters**.

3. **Share your findings.** One of the ways CDC communicates information is through social media. Your demonstrations can help CDC communicate the work they have done and are doing to improve access to polio vaccinations across the globe.

Why Participate? A Message from CDC

The quality of air in a community plays a large role in the health of that community. Air pollution can make it harder for people with asthma and other respiratory (breathing) diseases to breathe. Air pollution also can be harmful to heart health and may make it more likely that some people will have a heart attack or stroke. Learn the facts about air pollution and how you can keep your community healthy. By sharing air quality observations, members of a community can help inform environmental policies in their areas to keep all its residents safe.

More information about air quality can be found at: https://www.cdc.gov/air/air_health.htm

More information about tracking air pollutants can be found at: https://ephtracking.cdc.gov/showAirData.action

Think About It

1. What role did the community members of Norwood, Massachusetts play in tracking the air quality of their community?
2. What was CDC's response to air quality concerns in Norwood?
3. What role do **citizen scientists** play in monitoring air quality?

Design an Air Particle Observation and Air Filter

The engineering design process allows engineers to develop and test solutions to problems. You can use the process to help determine the best way to filter particles from the air. You will take two steps in this process: first you will observe the particles, then you will design a way to trap them.

Define the problem

Describe the problem you are trying to solve. There are several questions you could use to guide your investigation:

- What is the best method to collect air particles indoors?
- How can the amount of air particles observed change the air filter design?

Do background research

Find information about the problem.

- Check out this helpful link from CDC. https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/air.html#c3bi

Specify requirements

Determine what your solution needs to have to succeed.

- What are key characteristics needed for my air particle observation?
- What are the key characteristics needed for my air filter?

Brainstorm, choose and develop solutions

For each part of your design, ask yourself the following:

- How many different solutions can I create?
- Which solution seems to be the best one for the problem?
- What steps do I need to take to create my solution?

Build a prototype

Design your particle observation device and your air filter.

- It is okay if your prototype is made of different materials than your final solution. After all, it is a prototype.
- Be sure you can explain what each material represents.

Test and redesign

Test the prototype you made.

- For your particle observation, test multiple areas of the home.
- For your air filter, you can test it by measuring the amount of air particles it trapped as well as the amount of air it let pass.

Communicate results

Sharing the information you collect is key!

- Share your information using social media with the CDC accounts listed.

Conduct an Air Particle Investigation

Tools of the Trade

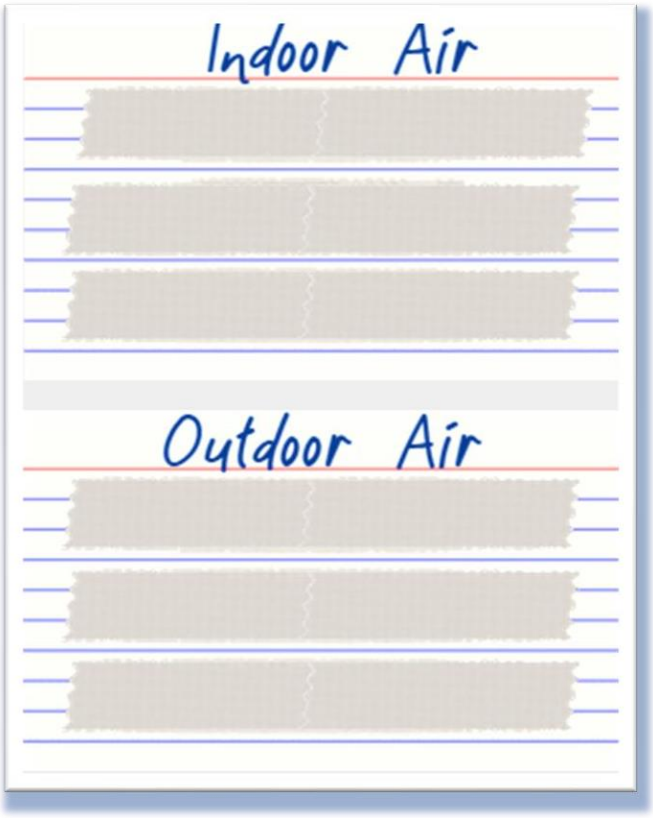
To conduct your particle observations, you will need:

Observation Cards

- 3x5" index cards x 2
- 2 feet double-sided tape
- 2-oz weights (can be rocks) x 2
- magnifying glass
- camera

Prepare the Observation Cards

1. Cut the double-sided tape into 4" strips.
2. Place 3 tape strips on each index card, one below the next.
3. Label the index cards "Indoor Air" and "Outdoor Air."



Place the Observation Cards

Note: These observations are best done when there is no rain in the forecast for several days.

4. Place the card labeled "Indoor Air" on a flat surface in your home that will not be disturbed, like a windowsill or table. Make sure it is in a room that receives good air flow, like a living room.
5. Place the card labeled "Outdoor Air" on a flat surface outside of your home that will not be disturbed, like a lawn chair or patio table. Make sure it is in an area that is also away from animals.

Collect Observation Data

6. Take a picture of each card once a day for 7 days. Try to take the picture at the same time each day if possible.
7. After taking the picture, examine each card with a magnifying glass to get a close look at the particles the cards collected. Record a description of the particles you observe (size, shape, color).
8. Organize the photos and the descriptions in the data table on the next page.

Observation Card Data Table

	Indoor Air Observation Card		Outdoor Air Observation Card	
	Image	**Description**	**Image**	**Description**
Day 1		Size, shape, color of particles		Size, shape, color of particles
Day 2				
Day 3				
Day 4				
Day 5				
Day 6				
Day 7				

Build an Air Filter

Tools of the Trade

Your **filter** will need to be housed inside a shoe box connected to an air source. In this case, the air source will be a hair dryer. For the shoebox design, you will need

roll of tape	**string – 1 foot**	**shoebox**
3x5" index cards - 4	**protractor**	**3x5" piece of foil**
ruler	**ground pepper**	**56 quart or larger clear box**
clear plastic wrap	**hair dryer**	**teaspoon measuring spoon**

Your **filter** will be made from your own design. Gather the recommended materials below to create your design.

tissue paper	**tulle or netting**	**fine mesh**
craft sticks	**coffee filters**	**paper towels or napkins**
tissue	**pipe cleaners**	**cloth squares**

Remember that since it is your design, you may think of other materials that could work as a good **filter**. You can use those as well!

Prepare the Filter House

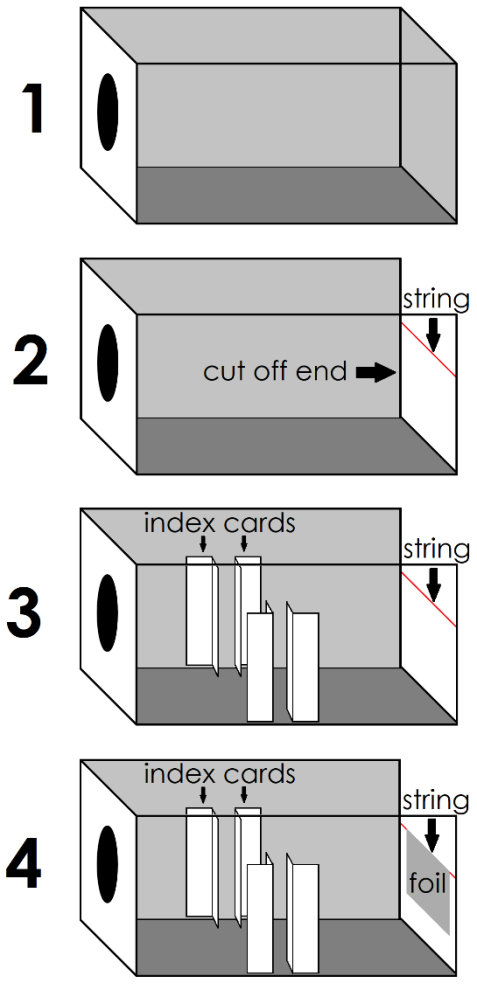
1. On one of the short sides of the shoebox, trace the end of the hairdryer and cut out the circle. This is where you will insert the hair dryer.

2. Cut the second short side of the box completely off so that the end is open. Tape the string across the opening horizontally, cutting off any excess.

3. Fold the index cards in half lengthwise. Tape the index cards in the inside middle of the shoe box 1 inch apart, as shown in the picture. The cards will hold your **filter** in place.

4. Fold the foil in half crosswise and hang it over the string. The movement of the foil will show how much air is traveling through your **filter**.

5. Test your device by placing the hairdryer in the hole and turning the dryer on low. Use a protractor to measure the angle created between the table and the foil as the foil blows. This measurement should be somewhere between 0 and 90 degrees. The angle represents air flow at 100%.



Build the Prototype

To build your **air filter**, you will first need to build a frame. Remember, the frame will need to fit inside the shoebox. Use your ruler to measure the height and width of the shoebox. Your **filter** will need to fit inside these measurements.

Once you have built your frame, you will need to cover it with material(s) that let(s) air through while blocking particles of pepper.

Some tips:

- Many **filters** have multiple layers to catch particles. However, more layers mean less air flowing through the **filter**.
- Aim to get at least 50% of the air through your **filter**. This means the angle between the table and the foil should be at least half as big as the first measurement. (For example, if the angle at 100% airflow is 90 degrees, then the airflow for your **filter** needs to be larger than 45 degrees.)
- Aim to block at least 50% of the pepper using your **filter**.

Once you have determined what your frame and **filter** layers will look like, draw a diagram with the **filter** parts labeled in the box below:

Test the Prototype

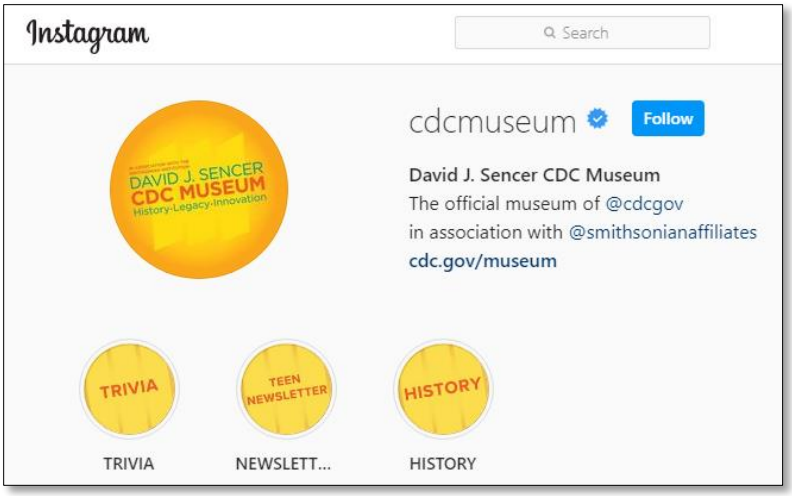
1. Place the large clear box on its side and place the shoebox, foil side first, inside the box.
2. Place your **filter** in the space created by the index cards.
3. Pour 2 teaspoons of pepper in the space between the **filter** and the hair dryer.
4. Turn the hairdryer on low and run it until all the pepper has gotten to the **filter**.
5. While the hairdryer is on, use the protractor to measure the angle created by the foil.
6. Turn the hair dryer off and measure the amount of pepper in the **filter**.
7. Repeat the test two additional times and record your results in the table below.

Prototype 1: Data Table			
	Trial 1	**Trial 2**	**Trial 3**
Air Flow	Original Angle: _____° Angle w/ Filter: _____°	Original Angle: _____° Angle w/ Filter: _____°	Original Angle: _____° Angle w/ Filter: _____°
Filtration	Amount of pepper caught by filter: _____teaspoons	Amount of pepper caught by filter: _____teaspoons	Amount of pepper caught by filter: _____teaspoons

Share Your Findings

The David J. Sencer CDC Museum uses award-winning exhibits and innovative programming to educate visitors about the value of public health and presents the rich heritage and vast accomplishments of CDC. Your demonstration could be a valuable contribution! Share your demonstration with the CDC Museum on Instagram using **@CDCMuseum**.

CDC has a social media presence dedicated to its work with the environment. You can aid CDC with these efforts by sharing your air particle data and pictures of your most successful trial. With a guardian's permission, log onto Twitter and share your prototype using **@CDCEnvironment.** Follow **@CDCEnvironment** on Twitter for info, tips, and news about ways your environment and your health are connected!



Name: _____

Reflections

Now that you have completed this investigation, think about what you learned from your research and experiment. Answer the questions below.

1. Which observation card collected the most air particles? What could have caused the amount of air particles you observed?

_____

_____

_____

2. Why would it be important to test your **air filter** in multiple settings?

_____

_____

_____

3. How often should air quality information in a community be shared with its residents? Why?

_____

_____

_____

4. What effect would clearing trees have on the air quality in a neighborhood?

_____

_____

_____

_____

5. Some plant species reduce air quality by introducing large amounts of pollen into the air. Should residents of a community have to obtain approval from their neighbors before planting these types of species? Why or why not?

_____

_____

_____

_____

6. Factories and plants are often built with little input from the surrounding communities. Should factories need approval from most residents in a community? Why or why not?

_____

_____

_____

_____

_____